SUPPLEMENT TO

THE ELECTRICAL WORLD

AN ILLUSTRATED WEEKLY REVIEW of CURRENT Progress in Electricity AND ITS PRACTICAL APPLICATIONS

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F. J. Sprague's Solution of the Problem of Rapid Transit for New York City.

The *Commercial Advertiser*, as may be known to many of our readers, has been making a magnificent fight for rapid transit in New York City, and we take pleasure in reprinting from its columns an interview with Mr. Sprague, the pioneer of electric traction, that is the best general discussion of the subject we have yet had the pleasure of reading. Mr. Sprague, on being interviewed by Mr. George H. Guy, the well-known newspaper correspondent of this city, and secretary of the New York Electrical Society, gave his views as follows:

For two years or more the question of rapid transit has easily held its position as the foremost subject demanding the immediate attention of New York. The urgent need of the city for some great improvement in its methods of communication, the eager discussion of the subject on every hand, the demand of the people as voiced by the press, by petition and its representatives, have finally made themselves felt, and we have a rapid transit bill and a commission empowered to give the necessary relief. And well it is, for New York has always been behindhand in providing for the people's needs.

The total annual passenger traffic—that is, the total number of persons carried in this city—has increased at the rate of over 140 per cent. in each period of 10 years since 1866, and is now something over 325,000,000. At the same rate of increase it would amount in 1890 to over 500,000,000 and in 1900 to 1,225,000,000.

Rapid transit is indeed urgent, but no less important is the proper solution of a plan which shall not only meet the needs of the New York of to-day, but that greater New York to which it is our pride to look forward. The decision of the plans of such a road should be based on the broadest conception, not only of the territorial growth of New York and its surroundings, but on due regard to the changes which shall take place, when narrow streets shall give way to broad ones, when street obstructions shall disappear, when permanent and perfect pavements shall be the rule, not the exception; when residences shall give way to business blocks, and when the most daring conceptions of architects and builders shall reach their fruition; when we shall point with pride to all that we see, and not with apologies to that we wish we could see.

To effect this would you advocate the building of the line simply on its own basis, or with regard to existing lines and outside connections?

It should be planned first of all to meet the requirements of New York City, the wants of the business and the laboring man, for women and children, for resident and visitor; to make communication as easy and as rapid as possible, not only between the residential and the business quarters of the city, but between the city and its suburbs, when such there shall be, and between the different parts of the business districts and the different parts of the residential districts; for social as well as business demands; in short, to get the most intimate communication between all parts of this city.

Such a road should not only be built in the most substantial manner, but with well-hedged privileges and franchises which, while protecting the city in its undoubted rights, should offer the certainty of fair and equitable returns to an investor, large or small, so that its bonds and stock should be as safe and as much sought after as a government bond.

Whatever the demands of our neighbors, whatever the plans suggested for our consideration, it must not be forgotten that New York wants rapid and convenient transit now and all the time, day and night, and that of every 100 passengers on the elevated railway or surface roads 99 have no call to go out of New York, and are solely concerned with the best means of getting from one part of New York to another in following their daily vocations.

I am not unmindful of the desirability of easy communication between New York and Brooklyn or Long Island City, or Hoboken or Jersey City, nor the value of every connecting link commercially possible between the great trunk lines which have done so much to build up New York; but consideration of this demand should not subordinate the real issue which is before us to-day, which is: How quickest and best can the inhabitants of one part of the city get to any other portion of it? The needs of New York must predominate, not the needs of its neighbors, which can properly be taken care of without sacrifice.

On what other important grounds do you advance such a view of the case?

That we may fully realize the demands of New York, it should be considered geographically. Since the annexed districts have been added the general contour is very much like that of the stock of a fowling-piece, with the breech at the Yonkers line, that is, the upper boundary of the Twenty-fourth district, the trigger guard coming in the Twenty-third district on the east side, almost in line with the 155th street station of the elevated railroad, and the barrel end at the Battery, 16 miles away. From the Battery to Grand Central station is a trifle over four miles. It is seven and a half miles to the upper end of the park, eight and a quarter to 125th street and nine miles to Harlem River. On the centre line of the city Jerome Park is as far from the upper boundary as is the Bowery and Cooper Union from the Battery. One Hundred and Twenty-fifth street is the centre of New York, Central Park being entirely within the lower half. The Forty-second street depot, being only one-quarter of the distance up, will in a not very distant future be "down town." Before 1900 its present function as a great passenger station for trunk lines will disappear, and these functions will be supplied by a large and much more magnificent depot, farther north, reached by rapid transit lines.

More than one-half the area of New York is above 125th street. With this great length, however, New York is limited by its water fronts. It attains a width of two miles at Grand street, a mile and a half from the Battery. It has the same width at Forty-second and 125th streets, and in all this stretch its widest portion is at Fourteenth street, where it is two and a half miles. Its greatest width, four and three quarter miles, and for a short distance only, that is, about one-fourth of the length of the Twenty-third district, is on a line through 125th street. The length of New York then, is about six times its mean width. Brooklyn, including Williamsburg, Jersey City and Hoboken are all opposite the lower quarter of New York, and Long Island City is opposite the second quarter.

It would seem from these facts and the wonderfully rapid extension and growth of New York in its upper section that the making of the rapid transit plan of New York depends upon the wants or needs of our neighbors, or, if the advocates of our greater New York prefer to put it, upon making the needs of the Manhattan section of New York City dependent upon the needs of its eastern and western districts, which would be the height of folly.

These districts can be well and properly served, when we consider their geographical situation, by properly constructed connecting links running under the East and North rivers, which links shall be designated for that purpose alone, and not necessarily as forming integral parts of the city system proper.

Will you briefly give your ideas as to the advantages of the more prominent plans which have engaged more or less seriously the attention of capitalists and the public, of which there are no less than fourteen?

Well, if we begin with the Beach pneumatic system, that was merged into the Broadway underground, and this in turn into the New York Arcade Railway Company, and it is now familiarly known as the "Arcade." Its advocates proposed to run from the Battery, thence to Broadway and Madison square, with four tracks, the two centre being express tracks, with stations one mile apart, and the two outer tracks for way traffic. Thence the route extends to Fifty-ninth street by Broadway, and to the Harlem River by Madison avenue, with an additional route up the west side of Central Park by the Boulevard or some other avenue and into the annexed district. Branches are proposed to connect Broadway and Madison avenue on Twenty-third street and the two branch roads on Forty-second street.

The Underground Railway Construction Company has pooled the issues of the New York District, New York Underground, and the Metropolitan Junction Company. The route of the first is similar to that of the Arcade, and runs from the Battery to Broadway and Madison square, with four tracks; thence up Broadway to Fifty-ninth street, and up Madison avenue over the Harlem River to some point near Jerome Park. Branches are also proposed from river to river on Twelfth and Twenty-third streets. The New York Underground road proposes to run from the City Hall Park east to Broadway, through Centre and Mulberry streets to Lafayette place and Fourth avenue, at Union square; thence by two lines to the Grand Central and Broadway and Fifty-ninth street, up the Boulevard to Kingsbridge, the main line continuing under Madison avenue to the Harlem River, and by a loop to Kingsbridge.

The Metropolitan Junction Company proposes to connect with the two last named in the annexed districts, and then run over the Hudson by a bridge at Washington Heights, connecting with a tunnel through the Palisades.

The City Railway Company proposes to begin at South and Whitehall streets, crossing Broadway below Rector, running between Church street and College place, Sixth and Seventh avenues to Fifty-ninth street and the Boulevard. The line would then run up the west side of Central Park, crossing the Harlem River above High Bridge, terminating in New Rochelle. Branches are proposed for the principal ferries on both rivers, the Post Office and Grand Central Station. The roadway is intended to be 50 feet wide and 12 feet below the surface; it is to have four tracks, two way and two express. It differs from the other underground railways in that, instead of taking the street lines, it proposes to purchase the necessary property and erect buildings over the line of the road, which are to be rented for sufficient to pay the bonds of the company. The road thus running through the basements, so to speak, of the buildings, and crossing the streets by tunnels, becomes a covered roadway instead of an open one.

The Terminal Underground Railway Company proposes a four-track underground railway from the City Hall along the proposed Elm street improvement to the Grand Central Depot.

The Metropolitan Transit Company proposes two elevated steel structures, one on Broadway, between Chambers street and Forty-third street, connecting with the Grand Central Depot, and the other on the west side following the line of the water front to Gansevoort Market, thence up Tenth avenue and the Boulevard to Kingsbridge.

What about Mr. Heman Clark's plan?

The plan proposed by Heman Clark is one of the most radical. He proposes a four-track tunnel, beginning near Fleetwood Park, cut in solid rock 150 feet below the surface, coming down about 100 feet west of the line of Broadway to the Astor House, where it would connect with two two-track branches, one going under the North River to Jersey City and Newark, and the other under the East River to Brooklyn and Prospect Park. Passenger stations would be at the foot of shafts sunk every two miles, and freight stations at intermediate shafts, where freight pockets would be tunneled. Large elevators would be used for handling the passengers and freight.

Then there is Austin Corbin's scheme?

Yes. One of the latest plans is that of the Metropolitan Underground Railway Company, at the head of which is Austin Corbin. The primary object of this company is apparently to make a connection from the trunk line railroads centered in Jersey City with the Long Island system by tunnel under the East and North rivers with connections for the New York City systems at Whitehall street, near the Battery. It is proposed as a subsequent proceeding to run four other sections, all double track, taking in the east and west sides of New York, and forming a loop around Jerome Park. The tunnel passing through solid rock its entire length would be over 100 feet below the curb of Broadway. Stations are common to both tracks, and would be reached by elevators of large carrying capacity. Electricity is proposed as a motive power, each car to have its own motor, and a speed of 30 miles an hour to be attained. However well this scheme has been worked out, its main object is primarily for the purpose of connecting the trunk line systems of Jersey City with the Long Island Railroad system, with New York as a sort of way station, with rapid transit in New York City as a secondary consideration to be provided in some remote future, after the carrying out of the initial project has been accomplished. As a matter of fact, the results proposed are contradictory, because no double track railroad operated with single car units, or, for that matter, train

units of any number of cars, can by any possibility give rapid transit to New York even to-day, much less when the road would be completed. New York cannot, and will not, make its rapid transit plans subservient to or dependent upon trunk line transportation, east, north, south or west, or upon the requirements of trans-Atlantic travelers.

Yet another scheme affecting New York is that of the New York and New Jersey Terminal Company, which proposes an underground railway starting from near Newark, where it is to make a junction with the Pennsylvania, the Delaware, Lackawanna & Western, the New Jersey Central, the Lehigh Valley and the Erie roads; thence running under the Hackensack River to Hoboken and thence to the Western end of Fourteenth street, New York, where the tunnel would be divided, one branch running to the Wall street section of the city and the other to a main terminal station at Union square. Other stations would be provided for both freight and passenger service. Electricity is proposed as the motive power. While this seems a very practical scheme for making connection with the west and south bound trunk lines, it is not rapid transit for New York City.

Various other plans have been proposed, but it will be unnecessary to discuss them, but to confine ourselves to a consideration of the only one that ever came to a fruition, the elevated system, and such other system as will best meet the wants of New York City.

A very inviting bill of fare, Mr. Sprague, but what do you think of the crust we now have?

The elevated system is of comparatively recent birth. It started with Harvey's elevated cable railroad, in 1868, which two years later was converted into a steam road and now forms the Ninth avenue division. The Third, Sixth and Second avenue railroads soon followed, and all were later consolidated into the Manhattan system, now carrying about 500,000 passengers daily.

Before outlining what I think is the only proper system for New York, it is desirable to consider briefly what opportunity the Manhattan system offers for a solution of the question asked: "Can this system be made available for the best rapid transit, and if not, what can be done to improve its service?" It labors under three great disadvantages. It is a double track system, it has no loop connections, and it is necessarily limited in speed.

Its service could be somewhat improved if, as is suggested, a connection should be built along the southern bank of the Harlem River, between the Second, Third and Eighth avenue division, the Y connection at the South Ferry station be abolished and property enough purchased for loop and storage tracks, so that trains could be operated in a continuous loop in both directions around the city. This would prevent some of the blocking and tedious delays which the present system of dispatching entails, but it would not give rapid transit.

A through connection by the Second avenue line with the Harlem River & Port Chester and the Suburban Rapid Transit roads would be of benefit to the people along these routes, but they would not have rapid transit. The addition of a third track with the necessary reconstruction or stiffening of the present structure would give faster time down in the morning, and faster time at night, but this would only be a makeshift, and would not meet the requirements of rapid transit.

Not even on the double-deck plan?

A double-story, four-track system such as has been proposed should not for one moment be tolerated. I would not disparage the good which has been done by the elevated roads, because New York owes in a very large measure her prosperity and growth to them; but this should not make us blind to the inefficiency of this system to meet the wants of to-day and the future, and it should be remembered that when the elevated railroads were built no such system of tunneling and locomotion as I shall outline was possible.

The replacing of steam by electricity, which could be done at a moderate expense, would do away with many of the objectionable features of the present system, but still we would not have rapid transit, and rapid transit is the living, crying need of New York to-day.

What is your idea of the plan best fitted to meet the requirements of the city?

To my mind no one of the foregoing plans can prove wholly satisfactory, and the plan I favor is: An independent and way express service, each having double tracks, but having independent paths, run in independent circular iron tunnels, and forming a loop around the city from the Battery to Jerome Park; the express and way tracks to intersect or join at different levels at common stations, and to be operated by electricity; way tracks to have stations every third of a mile, express every mile and a half; and a loop to be provided just south of the Harlem River. There would also be a cross-town two-track system running beneath the city division, intersecting it on the east and west sides of the Forty-second street line and at the Battery, and making connection with the Long Island, Broadway and Atlantic avenue stations on the east and trunk line depots on the west.

What are the considerations that make this general plan the best?

Independence of express and way service is essential. The operation of express and way trains on a two-track railroad, to meet the condition of service of New York City, should not be thought of. It is impossible to satisfactorily so operate to-day; it will be vastly more so 20 years from now. A moment's consideration of the essentials of way and express service both in the matter of carrying passengers, making high speed, running at short intervals, handling heavy trains, economical use of power and allowable capacity of engines will show this.

To illustrate this point, we have only to consider the work done on the Third avenue elevated road, such as it was a short time ago, and it cannot be less to-day. I have made a special study of it for six years past.

This road is eight and a half miles long. Grades vary from 8 to 105 feet to the mile. The level stretches amount to about one-third of the whole distance, and this includes the stations. On the 17 miles of single track there are 52 stations. In the busy hours there are no less than 63 four and five-car trains on the tracks. These trains, weighing from 80 to 95 tons, make the half trip in 42 minutes, including stopping at 26 stations and discharging and taking on passengers, or at the rate of about 10 traffic miles per hour. The work of the engines may be divided into three parts, viz., overcoming the train's inertia, lifting the train on the grades, and traction, and the maximum is at least seven times that necessary for traction at mean speed on a level. Three times in every mile this weight of 80 to 95 tons must be started from a dead rest, raised to a speed of 20 or more miles an hour and brought to rest in about 80 seconds. The engines are run with 130 pounds boiler pressure and have a capacity of 185 h. p. Fifty-nine per cent. of the power on a round trip is used in accelerating speed, 24 per cent. in lifting and 17 per cent. in traction, and the average power developed per minute per round trip, including stoppages, is 70.3 h. p.

These are instructive figures, which alone should show the fallacy of a two-track system. They show that it is perfectly certain that on the present elevated system a greater traffic speed than 10 miles an hour cannot be maintained, while it is equally true on the other hand that we cannot consider any less frequent stations for way service than three to a mile, yet note what tremendous duty is required of engines to make even this moderate speed under conditions of frequent stops. Under the conditions here given on such portion of the road as is fairly straight and with easy grades, a maximum speed of about 22 miles an hour must be attained, but on a road like the Sixth avenue and Harlem division, where there are many sharp curves, and grades as high as 2 per cent., the maximum speed must rise as high as 28 miles an hour to make the schedule time, and this speed can only be attained on a fairly long stretch as between the Fifty-ninth and Seventy-second street stations. Ten miles an hour is slow enough speed; it ought to be 15 at least, which, under excellent conditions, that is, on a road free from disadvantageously situated grades and with no sharp curves, would acquire a speed of about 33 miles an hour. With a long stretch between stations, the average speed is very much nearer the maximum, and the same motive power which will handle a way train on short intervals will handle an express train at longer intervals easily at double the main speed, say 30 miles an hour, with a maximum of 40 miles. Therefore express trains ought to stop only about once in a mile and a half, or say every fifth way station. It should be noted that on an express train, stopping at few stations, not only would much less time be spent in getting under way and stopping, but also at rest at stations taking on and discharging passengers, so that I am well within bounds when I say that a motor which can do the service of a way train at short intervals can equally well do the work of a heavy express train at long intervals.

Do we need to stick to daylight travel and the use of New York City as a big sounding board?

That a rapid transit road should be built below the surface seems apparent, and the use of electricity as motive power, and the modern systems of tunneling, and the perfection to which elevator service has attained should make the advantages of an underground system clear and its success unquestionable. Any four-track system if run above ground must almost of necessity be run over a common route. If it follows the street it is impossible to get the room for four tracks unless one set of tracks is placed above the other. The road must be largely dependent upon street grades and street curves, If cut through blocks so as to get more room and direct lines, the cost of the property condemned, and the investment necessary, would be enormous, and there would still remain the objection of crossing streets every 250 feet. Furthermore, any surface or elevated system is exposed to weather obstructions, whether in the form of a fog, which necessitates slow and cautious running, or ice and snow, which impede the way and increase the slip of the motor. An elevated structure, except when very massively built, cannot have the same rigidity that a tunnel structure has. There is always the danger of derailment, a tumble into the street, and a greater liability of train collision If an individual tunnel construction be used there would not only be no room for a train to fall, but a broken axle or a derailed train would not, of itself, be apt to prove serious. The tunnels would be lighted constantly and uniformly; the rails would be always in perfect condition for adhesion, and the temperature of the tunnel would be almost constant. Heating of the trains or stations would be unnecessary. Ventilation could be made perfect.

But we shall miss our flitting glimpses of second story scenery!

Cars for such underground systems would require no windows, landscape views not being essential to rapid transit in a city, and hence with the same weight, can be more strongly constructed. Absolute freedom from sharp curves and the arranging of grades so that, instead of being a detriment, they can be of positive aid in train service, are not among the least advantages of an underground system. Where curves occur, they can be either on a dead level or the grades can be so managed that they will be of service.

Would you have one large tunnel or a number of tunnels?

Having determined upon a tunnel construction, independence of express and way tracks is not all that is essential. These might be obtained if all four tracks were in a common tunnel, but when we realize some of the other conditions which must be met, and that such a four-track system could not be placed in a common tunnel not less than 50 feet in width and 20 feet in height, objections to such construction are pronounced. It is manifest also, that if the size of a tunnel for four tracks has objections structurally and otherwise, one for two tracks must have similar objections, although in a less degree. Hence my plan is a system of independent express and way routes, each having two tracks, each carried in independent tunnels, and having their paths intersect at certain common important points, say on an average every mile and a half. I would have not only the routes of these services independent of each other, save at their common meeting points, but I would have them, at all other points, independent also in the matter of grade, and furthermore, I should have the tunnels of each system, while normally running side by side, sufficiently independent to permit of such variation of route for each track as the meeting of obstructions in the construction should require; or briefly, I would have four independent tunnels, all four meeting at a common station once every mile and a half, and the way tunnels meeting at common stations every third of a mile.

What are the advantages of such a method?

1. A much stronger construction is possible with the same weight of materials, because a tunnel of 12 or 13 feet in diameter can be built with strength to support a given outside pressure with much less than one-quarter of the weight of material required to build a tunnel of four times the area, and a tunnel to accommodate four tracks would have more than four times the area of a tunnel to accommodate one.

2. At any given depth there will be far less interference with and danger to the foundations of a building with a small tunnel than with a large one; in fact, a tunnel of the smaller size could be run with perfect safety almost through and certainly under or alongside the very foundations of the heaviest buildings.

3. The nearer the surface a system is run the greater the variety of obstructions which will be met, which with a large tunnel would require a very costly change of gas, sewer and other pipes. A 13-foot tunnel, independently run, could easily deviate up or down, to the right or left, in fact, weave its way through and around obstructions, which it would be impossible to do with a larger tunnel. This is one of the very greatest advantages to be obtained with the independent tunnel construction.

Is any special plan necessary for the express route?

The express route, if a difference of level exists between express and way tracks, should be the lower one, and being lower it can run in more direct lines with less necessity of divergence on account of obstructions. While the express tracks should thus run in the most direct line possible between main stations, the way tracks could take a more or less divergent path as determined by the best positions for the way stations. On this account the express route will be somewhat shorter than the way, which would be an important help to a quick schedule time.

If, as should be the case, the tunnel is built of iron and of circular cross section, not only will the construction be the strongest which can be built for any given clearance, but with the minimum of excavations. Its safety would consist in its arch presenting the maximum of resistance to vertical and side pressure. The thickness can be varied to suit the condition of strain to be met.

Do you think that such a method would materially lessen the difficulties of construction?

I do; but in considering the strength of construction and facility for finding a path, we must consider the time occupied also. By sinking shafts at sufficiently short intervals, and working in both directions on all headings, the construction of way and express tunnels can go ahead simultaneously and independently, each being completed at the earliest moment, and no tunnel being dependent upon any abnormal obstruction or difficulties which may be found in the way in the construction of another. A greater force of men can be used, the débris can be carried away more rapidly, and, in short, the whole work can be carried forward far more expeditiously and safely with the independent tunnel construction than with a larger tunnel, unless the latter were driven through solid rock at a very great depth. Of course, an accurate survey of the pipes and foundations of the city should be made, and a great deal of other preliminary work would have to be done. I think, however, I am safe in saying that such a survey, the deter-

TABLE OF ELECTRICAL HORSE POWERS.

Read ampères at top and volts at side, or *vice versa*.

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The formula which was used to obtain the figures in this table is

$$\frac{\text{Volts} \times \text{ampères}}{746} = \text{Elec. h. p.}$$

AMPERES OR VOLTS.

Volts or ampères.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Volts or ampères.
1	.00134	.0027	.00402	.00536	.0067	.00801	.00938	.0107	.0120	.0134	.0147	.0160	.0174	.01876	.0201	.0214	.0227	.0241	.0254	.0268	.0282	.0294	.0308	.03 1	.0335	1
2	.00268	.0054	.00804	.0107	.0134	.01608	.0188	.0214	.0240	.0268	.0295	.0322	.0349	.03753	.0402	.0429	.0455	.0482	.0509	.0536	.0563	.0590	.0616	.0643	.0670	2
3	.00402	.0080	.0120	.0161	.0201	.0 41	.0_92	.0322	.0362	.0402	.0442	.0483	.0523	.05630	.0603	.0643	.0684	.0724	.0764	.0804	.0845	.0885	.0925	.0965	.10 5	3
4	.00536	.0107	.0160	.0214	.0268	.0321	.0375	.0429	.0483	.0536	.0590	.0643	.0697	.0751	.0804	.0858	.0912	.0965	.1019	.1072	.1126	.1180	.1233	.1287	.1340	4
5	.00670	.0134	.0201	.0268	.0335	.0402	.0469	.0536	.0603	.0670*	.0737	.0804	.0871	.0938	.1005	.1072	.1139	.1206	.1273	.1340*	.1408	.1475	.1542	.1609	.1676	5
6	.00804	.0160	.0241	.0322	.0402	.0482	.0563	.0643	.0724	.0804	.0885	.0965	.1046	.1126	.1206	.1287	.1367	.1448	.1528	.1679	.1689	.1769	.1850	.1930	.2011	6
7	.00938	.0187	.0281	.0375	.0469	.0562	.0657	.0751	.0845	.0938	.1032	.1126	.1220	.1314	.1406	.1501	.1595	.1689	1783	.1877	.1971	.2064	.2158	.2252	.2346	7
8	.0107	.0214	.0321	.0429	.0536	.0642	.0751	.0853	.0965	.1072	.11?0	.1287	.1394	.1501	.1609	.1716	.1823	.1930	.2038	.2145	.2232	.2339	.2466	.2574	.2681	8
9	.0120	.0241	.0361	.0483	.0603	.0722	.0845	.0965	.1086	.1206	.1327	.1448*	.1538	.1689	.1810	.1930	.2051	.2172	.2292	.2413	.2534	.2654	.2775	.2895	.3016	9
10	.0134	.0268	.0402	.0536	.0670*	.0804	.0938	.1072	.1206	.1340	.1475	.1609	.1743	.1876	.2011*	.2145	.2279	.2413	.2547	.2681	.2815	.2949	.3083	.3217	.335*	10
11	.0147	.0294	.0442	.0590	.0737	.0884	.1032	.1179	.1327	.1475	.1622	.1769	.1917	.2064	.2212	.2359	.2507	.2654	.2802	.2949	.3097	.3244	.3391	.3539	.3686	11
12	.016)	.0321	.0482	.0643	.0804	.0961	.1126	.1287	.1448	.1609	.1769	.1930	.2091	.2252	.2413	.2574	.2735	.2895	.3056	.3217	.3378	.3539	.3700	.3860	.4021	12
13	.0174	.0348	.0522	.0697	.0871	.1044	.1220	.1394	.1568	.1743	.1916	.2091	.2265	.2440	.2614	.2788	.2962	.3137	.3311	.3485	.3660	.3834	.4008	.4182	.4357	13
14	.0187	.0375	.0563	.0751	.0938	.1126	.1314	.1501	.1689	.1877	.2064	.2252	.2440	.2627	.2815	.3003	.3190	.3378	.3566	.3753	.3941	.4129	.4316	.4504	.4692	14
15	.0201	.0402	.0603	.0804	.1005	.1206	.1408	.1609	.1810	.2011*	.2212	.2413	.2614	.2815	.3016	.3217	.3418	.3619	.3820	.4021*	.4223	.4424	.4625	.4826	.5027	15
16	.0214	.0428	.0643	.0858	.1072	.1286	.1501	.1715	.1930	.2145	.2359	.2574	.2788	.3003	.3317	.3432	.3646	.3861	.4075	.4290	.4504	.4718	.4933	.5147	.5362	16
17	.0227	.0455	.0683	.0912	.1139	.1366	.1595	.1823	.2051	.2279	.2507	.2735	.2962	.3190	.3418	.3646	.3874	.4102	.4330	.4558	.4796	.5013	.5241	.5469	.5697	17
18	.0241	.0482	.0723	.0962	.1206	.1446	.16 9	.1930	.2172	.2413	.2650	.2895	.3137	.3378	.3619	.3861	.4102	.4343	.4584	.4826	.5067	.5308	.5550	.5791	.6032	18
19	.0254	.0509	.0764	.1019	.1273	.1528	.1783	.2038	.2292	.2547	.2802	.3056	.3311	.3566	.3820	.4075	.4330	.4584	.4839	.5091	.5349	.5603	.5858	.6113	.6367	19
20	.0268	.0536	.0804	.1072	.1340*	.1608	.1877	.2148	.2413	.2681	.2949	.3217	.3485	.3753	.4021*	.4290	.4558	.4825	.5094	.5361	.5630	.5898	.6166	.6434	.670*	20
21	.0281	.0562	.0844	.1126	.1408	.1688	.1971	.2252	.2534	.2815	.3097	.3378	.3660	.3940	.4223	.4504	.4786	.5067	.5349	.5630	.5912	.6193	.6475	.6756	.7038	21
22	.0294	.0589	.0884	.1180	.1475	.1768	.2064	.2359	.2654	.2949	.3244	.3539	.3834	.4129	.4424	.4718	.5013	.5308	.5603	.5898	.6193	.6488	.6783	.7078	.7373	22
23	.0308	.0616	.0924	.1233	.1542	.1848	.2158	.2466	.2775	.3083	.3391	.3700	.4008	.4316	.4625	.4933	.5241	.5550	.5858	.6166	.6475	.6783	.7091	.7399	.7777	23
24	.0321	.0643	.0965	.1 87	.1609	.1930	.2252	.2574	.2895	.3217	.3539	.3861	.4182	.4504	.4825	.5147	.5469	.5791	.6113	.6434	.6756	.7078	.7399	.7721	.8043	24
25	.0335	.0670	.1005	.1340	.1676	.2010	.2346	.2681	.3016	.3351*	.3686	.4021	.4357	.4692	.5027	.5362	.5697	.6032	.6367	.6702*	.7038	.7373	.7708	.8043	.8378	25
26	.0348	.0697	.1045	.1394	.1743	.2090	.2440	.2788	.3137	.3485	.3834	.4182	.4431	.4879	.5228	.5576	.5925	.6273	.6622	.6971	.7319	.7668	.8016	.8365	.8713	26
27	.0361	.0723	.1085	.1448	.1810	.2170	.2534	.2895	.3257	.3619	.3981	.4343	.4706	.5067	.5429	.5791	.6 53	.6515	.6877	.7239	.7601	.7962	.8324	.8686	.9048	27
28	.0375	.0750	.1126	.1501	.1877	.2252	.2627	.3003	.3378	.3753	.4129	.4504	.4879	.5255	.5630	.6005	.6381	.6756	.7131	.7507	.7882	.8257	.8633	.9008	.9383	28
29	.0388	.0777	.1166	.1554	.1944	.2332	.2721	.3110	.3499	.3887	.4276	.4665	.5054	.5442	.5831	.6220	.6609	.6997	.7386	.7775	.8164	.8552	.8941	.9330	.9718	29
30	.0402	.0804	.1206	.1609	.2011*	.2412	.2815	.3217	.3619	.4021	.4424	.4826	.5227	.5630	.6032*	.6434	.6836	.7239	.7641	.8 43	.8445	.8847	.9249	.9651	1.005*	30
31	.0415	.0831	.1246	.1662	.2078	.2492	.2909	.3324	.3740	.4155	.4571	.4987	.5402	.5818	.6233	.6649	.7064	.7480	.7895	.8311	.8727	.9142	.9558	.9973	1 039	31
32	.0428	.0857	.1286	.1716	.2145	.2572	.3008	.3432	.3861	.4290	.4718	.5147	.5576	.6005	.6434	.6863	.7292	.7721	.8150	.8579	.9008	.9437	.9866	1.029	1.072	32
33	.0442	.0884	.1327	.1769	.2212	.2654	.3097	.3539	.3981	.4424	.4868	.5308	.5751	.6193	.6635	.7078	.7520	.7962	.8405	.8847	9290	.9732	1.017	1.062	1.105	33
34	.0455	.0911	.1367	.1823	.2279	.2734	.3190	.3646	.4102	.4558	.5013	.5469	.5925	.6381	.6 46	.7292	.7748	.8204	.8660	.9115	.9571	1.003	1.048	1.094	1.139	34
35	.0469	.0938	.1407	.1877	.2346	.2814	.3284	.3753	.4223	.4692*	.5161	.5630	.6099	.6568	.7038	.7507	.7976	.8445	.8914	.9383*	.9853	1.032	1.079	1.126	1.173	35
36	.0482	.0965	.1447	.1920	.2413	.2894	.3378	.3861	.4343	.4826	.5308	.5791	.6273	.6756	.7239	.7721	.8201	.8686	.9169	.9601	1.013	1.062	1.110	1.158	1.206	36
37	.0495	.0991	.1487	.1984	.2480	.2974	.3472	.3968	.4464	.4960	.5456	.5952	.6448	.6944	.7440	.7936	.8432	.8928	.9424	.9920	1.042	1.091	1.141	1.190	1.240	37
38	.0509	.1018	.1528	.2038	.2547	.3056	.3566	.4075	.4584	.5094	.5603	.6113	.6622	7131	.7641	.8150	.8660	.9169	.9378	1.019	1.070	1.121	1.172	1.223	1.273	38
39	.0522	.1045	.1568	.2091	.2614	.3136	.3659	.4182	.4705	.5228	.5751	.6273	.6796	.7319	.7842	.8365	.8887	.9410	.9933	1.046	1.094	1.150	1.202	1.255	1.307	39
40	.0536	.1072	.1608	.2145	.2680*	.3216	.3753	.4290	.4825	.5362	.5898	.6434	.6971	.7507	.8043*	.8579	.9115	.9651	1.019	1.072	1.126	1.180	1.233	1.287	1.340*	40
41	.0549	.1099	.1648	.2198	.2748	.3296	.3847	.4397	.4946	.5495	.6046	.6595	.7145	.7649	.8244	.8794	.9343	.9893	1.044	1.093	1.154	1.209	1.264	1.319	1.374	41
42	.0562	.1125	.1689	.2252	.2815	.3376	.3941	.4504	.5067	.5630	.6193	.6756	.7319	.7882	.8495	.9008	.9571	1.013	1.070	1.126	1.182	1.239	1.295	1.351	1.408	42
43	.0576	.1152	.1729	.2306	.2882	.3458	.4035	.4611	.5188	.5724	.6340	.6917	.7493	.8070	.8646	.9223	.9799	1.038	1.095	1.153	1.210	1.268	1.326	1.383	1.441	43
44	.0589	.1179	.1769	.2359	.2919	.3538	.4129	.4718	.5308	.5898	.6488	.7078	.7668	.8257	.8847	.9437	1.003	1.062	1.121	1.180	1.239	1.298	1.357	1.416	1.475	44
45	.0603	.1206	.1809	.2413	.3013	.3618	.4223	.4825	.5429	.6032*	.6635	.7239	.7842	.8445	.9048	.9651	1.025	1.086	1.146	1.206*	1.267	1.327	1.387	1.448	1.508	45
46	.0616	.1233	.1849	.2466	.3083	.3698	.4316	.4933	.5550	.6166	.6783	.7399	.8016	.8633	.9249	.9866	1.048	1.120	1.172	1.233	1.295	1.357	1 418	1.480	1.542	46
47	.0629	.1259	.189	.2520	.3150	.3780	.4400	.5040	.5670	.6309	.6930	.7560	.8190	.8820	.9450	1.008	1.071	1.134	1.197	1.260	1.323	1.386	1.449	1.512	1.575	47
48	.0643	.1286	.1930	.2574	.3217	.3860	.4501	.5147	.5791	.6434	.7078	.7721	.8335	.9008	.9651	1.029	1.094	1.158	1.223	1.287	1.351	1 416	1.480	1.544	1.609	48
49	.0656	.1313	.1970	.2627	.3284	.3941	.4598	.5255	.5912	.6568	.7225	.7882	.8539	.9196	.9853	1.051	1.117	1.182	1.248	1.314	1.379	1.445	1.511	1.576	1.642	49
50	.0670	.1340	.2010	.2681	.3351*	.4021	.4692	.5362	.6032	.6702	.7373	.8043	.8713	.9383	1.005*	1.072	1.139	1.206	1 273	1.340	1.403	1.475	1.542	1.609	1.676*	50
51	.0684	.1367	.2050	.2735	.3418	.4102	.4785	.5469	.6153	.6836	.7520	.8204	.8857	.9571	1.025	1.094	1.162	1.231	1.299	1.367	1.436	1.504	1.572	1.641	1.709	51
52	.0697	.1394	.2091	.2788	.3485	.4182	.4879	.5576	.6273	.6971	.7638	.8335	.9062	.9759	1.046	1.113	1.185	1.255	1.324	1.394	1.464	1.534	1.603	1.673	1.743	52
53	.0711	.1421	.2131	.2842	.3552	.4263	.4973	.5684	.6391	.7105	.7815	.8525	.9236	.9946	1.066	1.137	1.208	1.279	1.350	1.421	1.492	1.563	1.634	1.703	1.776	53
54	.0723	.1448	.2171	.2895	.3319	.4343	.5037	.5791	.651?	.7239	.7962	.8383	.9410	1.013	1.086	1.158	1.231	1.303	1.375	1.448	1.520	1.592	1.665	1.737	1 810	54
55	.0737	.1475	.2211	.2949	.3386	.4424	.5161	.5898	.6335	.7373	.8110	.8847	.9584	1.032	1.106	1.180	1.253	1.327	1.401	1.475	1.548	1.622	1.696	1.769	1.843	55
56	.0751	.1501	.2255	.3003	.3753	.4504	.5255	.6005	.6756	.7507	.8257	.9008	.9759	1.051	1.126	1.201	1.276	1.351	1.426	1.501	1.576	1.651	1.727	1.802	1.877	56
57	.0764	.1528	.2292	.3056	.3820	.4584	.5349	.6113	.6877	.7611	.8405	.9168	.9933	1.070	1.146	1.223	1.299	1.375	1.452	1.528	1.665	1.681	1.757	1.834	1.910	57
58	.0777	.1555	.2332	.3110	.3887	.4665	.5442	.6220	.6997	.7775	.8552	.9330	1.011	1.088	1.166	1.244	1.322	1.399	1.477	1.555	1.633	1.710	1.788	1.866	1.944	58
59	.0791	.1582	.2372	.3164	.3954	.4745	.5536	.6327	.7118	.7909	.8700	.9491	1.028	1.107	1.186	1.265	1.345	1.424	1.503	1.582	1.661	1.740	1 819	1.898	1.978	59
60	.0804	.1609	.2412	.3217	.4021	.4826	.5630	.6434	.7239	.8043	.8847	.9651	1.046	1.126	1.206	1.287	1.367	1.448	1.528	1.609	1.689	1.769	1.850	1.930	2.011	60
61	.0818	.1635	.2453	.3271	.4088	.4906	.5724	.6542	.7359	.8177	.8995	.9812	1.063	1.145	1.227	1.308	1.390	1.472	1.554	1.635	1.717	1.799	1.881	1.962	2.044	61
62	.0831	.1662	.2493	.3324	.4155	.4987	.5818	.6649	.7480	.8311	.9142	.9973	1.080	1.164	1.247	1.330	1.413	1.496	1.579	1.662	1 745	1.828	1.912	1.995	2.078	62
63	.0845	.1689	.2533	.3378	.4223	.5057	.5912	.6756	.7601	.8445	.9290	1.013	1.098	1.182	1 267	1.351	1.436	1.520	1.605	1.689	1.773	1.858	1.942	2.027	2.111	63
64	.0858	.1716	.2573	.3432	.4290	.5147	.6005	.6863	.7721	.8579	.9437	1.029	1.115	1.201	1.287	1.373	1.458	1.544	1.630	1.716	1 802	1.887	1.973	2.059	2.145	64
65	.0872	.1743	.2613	.3485	.4357	.5228	.6039	.6971	.7812	.8713	.9584	1.046	1.133	1.220	1.307	1.394	1.481	1.568	1.655	1.743	1.830	1.917	2.004	2.091	2.178	65
66	.0885	.1769	.2654	.3539	.4424	.5308	.6193	.7078	.7962	.8847	.9732	1.062	1.150	1.239	1.327	1.416	1.504	1.592	1.681	1.769	1.858	1.946	2.035	2.123	2.212	66
67	.0898	.1796	.2694	.3592	.4491	.5389	.6287	.7185	.8083	.8981	.9879	1.078	1.168	1.257	1.347	1.437	1.527	1.617	1.706	1.796	1.886	1.976	2.066	2.155	2.245	67
68	.0912	.1823	.2734	.3646	.4552	.5469	.6381	.7292	.8204	.9115	1.0027	1.094	1.185	1.276	1.367	1.458	1.550	1.641	1.732	1.823	1.914	2.006	2.097	2.188	2.279	68
69	.0925	.1850	.2774	.3700	.4625	.5550	.6475	.7499	.8324	.9249	1.017	1.110	1.202	1.295	1 387	1.480	1.572	1.665	1.757	1.850	1.942	2.035	2.127	2.220	2.312	69
70	.0938	.1877	.2815	.3753	.4692	.5630	.6568	.7507	.8445	.9383	1.032	1.126	1.220	1.314	1.408	1.501	1.595	1.689	1.783	1.877	1.971	2.064	2.158	2.252	2.346	70
71	.0952	.1903	.2855	.3807	.4759	.5710	.6662	.7614	.8566	.9517	1.047	1.142	1.237	1.332	1.428	1.528	1.618	1.713	1.808	1.903	1.999	2.094	2.189	2.284	2.379	71
72	.0965	.1930	.2895	.3861	.4826	.5791	.6756	.7721	.8686	.9651	1.062	1.158	1.255	1.351	1 448	1.544	1.641	1.737	1.834	1.930	2.027	2.123	2.220	2.316	2.413	72
73	.0979	.1957	.2936	.3914	.4893	.5871	.6850	.7828	.8807	.9786	1 076	1.174	1.272	1.370	1.468	1.566	1.664	1.761	1.859	1.957	2.055	2.153	2.251	2 349	2.446	73
74	.0992	.1984	.2976	.3968	.4960	.5952	.6944	.7936	.8928	.9920	1.091	1.190	1.290	1.389	1.488	1.587	1.686	1.786	1.885	1.984	2.083	2.182	2.282	2.381	2 480	74
75	.1005	.2011	.3016	.4021	.5027	.6032	.7038	.8043	.9048	1.005	1.106	1.206	1.307	1.408	1.508	1.609	1.709	1 810	1.910	2.011	2.111	2.212	2.312	2.413	2.513	75
76	.1019	.2038	.3056	.4075	.5094	.6113	.7131	.8150	.9169	1.019	1.121	1.223	1.324	1.426	1 528	1.630	1.732	1.834	1.936	2.038	2.139	2.241	2.343	2.445	2.547	76
77	.1032	.2064	.3096	.4129	.5161	.6193	.7225	.8257	.9.90	1.052	1.135	1.239	1.342	1.445	1.548	1.651	1.755	1.858	1.961	2.064	2.168	2.271	2.374	2.477	2.580	77
78	.1046	.2091	.3136	.4182	.5228	.6273	.7319	.8365	.9410	1.046	1.150	1.255	1.359	1.464	1.568	1.673	1.778	1.882	1.987	2.091	2.196	2.300	2.405	2.509	2.614	78
79	.1059	.2118	.3195	.4236	.5295	.6351	.7413	.8472	.9531	1.059	1.165	1.271	1.377	1.483	1.588	1.694	1.800	1.906	2.012	2.118	2.224	2.330	2.436	2.54?	2.647	79
80	.1072	.2145	.3216	.4289	.5362	.6434	.7507	.8579	.9651	1.072	1.180	1.287	1.394	1.501	1.609	1.716	1.823	1.930	2.038	2.145	2.252	2.359	2.466	2.574	2.681	80
81	.1086	.2172	.3257	.4343	.5429	.6515	.7601	.8686	.9772	1.086	1.194	1.303	1.412	1.520	1.629	1.737	1.846	1.954	2.063	2.172	2.280	2 389	2.497	2.606	2.714	81
82	.1099	.2198	.3297	.4397	.5496	.6595	.7694	.8794	.9893	1.099	1.209	1.319	1.429	1 539	1.649	1.759	1.869	1.979	2 088	2.198	2.308	2.418	2.528	2 638	2.748	82
83	.1113	.2225	.3337	.4450	.5563	.6676	.7788	.8901	1.001	1.113	1.224	1.335	1.446	1.557	1.669	1.780	1.891	2.003	2.114	2.225	2.336	2.448	2.559	2.670	2.781	83
84	.1126	.2252	.3377	.4504	.5630	.6756	.7882	.9008	1.013	1.126	1.239	1.351	1.464	1.576	1.689	1.802	1.914	2.027	2.139	2.252	2.365	2.477	2.590	2.702	2.815	84
85	.1139	.2279	.3418	.4558	.5697	.6836	.7976	.9115	1.025	1.139	1.253	1.367	1.481	1.595	1.709	1.823	1.937	2.051	2.165	2.279	3.393	2.507	2.621	2.735	2.849	85
86	.1153	.2306	.3458	.4611	.5764	.6917	.8070	.9223	1.038	1.153	1.268	1.383	1.499	1.614	1.729	1.845	1.960	2.075	2.190	2.306	2.421	2.536	2.651	2.767	2.882	86
87	.1166	.2332	.3498	.4665	.5831	.6997	.8164	.9330	1.050	1.163	1.283	1.399	1.516	1.633	1.749	1.866	1.983	2.099	2.216	2.332	2.449	2 566	2.682	2.799	2.916	87
88	.1180	.2359	.3538	.4718	.5898	.7078	.8257	.9437	1 062	1.180	1.298	1.416	1.534	1.651	1.769	1.887	2.005	2.123	2.241	2.359	2.477	2.595	2.713	2.831	2.949	88
89	.1193	.2386	.3579	.4772	.5965	.7158	.8351	.9544	1.074	1.193	1 312	1.432	1.551	1.670	1.790	1.909	2.028	2.147	2.267	2.386	2.505	2.625	2.744	2.863	2.983	89
90	.1207	.2412	.3619	.483	.6032	.7239	.8445	.9652	1.086	1.206	1.327	1.448	1.569	1.689	1.810	1.930	2.051	2.172	2.292	2.413	2 534	2.654	2 775	2.895	3.016	90
91	.1220	.2440	.3659	.4879	.6099	.7319	.8539	.9759	1.098	1.220	1.342	1.464	1.586	1.708	1.830	1.952	2.074	2 196	2.318	2.440	2.562	2.684	2.806	2.928	3 050	91
92	.1233	.2466	.3699	.4933	.6166	.7399	.8633	.9866	1.110	1.233	1.357	1.480	1.603	1.726	1.850	1.973	2.097	2.220	2.343	2.466	2.590	2.713	2.836	2.960	3.083	92
93	.1247	.2193	.3739	.4987	.6233	.7480	.8727	.9973	1.122	1.247	1.371	1.496	1.621	1.745	1.870	1.995	2.119	2.244	2.369	2.493	2.618	2.743	2.867	2.992	3.117	93
94	.1260	.2520	.3780	.5040	.6300	.7560	.8820	1.008	1.134	1.260	1.386	1.512	1.638	1.764	1.890	2.016	2.142	2.268	2.394	2.520	2.646	2.772	2.898	3.024	3.150	94
95	.1274	.2547	.3820	.5094	.6367	.7641	.8914	1.019	1.146	1.273	1.401	1.528	1.655	1.783	1.910	2.038	2.165	2.292	2.420	2.547	2.674	2.802	2.929	3.056	3.184	95
96	.1287	.2574	.3860	.5147	.6434	.7721	.9008	1.030	1.158	1.287	1.416	1.544	1.673	1.802	1.930	2.059	2.188	2.316	2.445	2.574	2.702	2.831	2.960	3.088	3.217	96
97	.1300	.2601	.3900	.5201	.6501	.7802	.9102	1.040	1.170	1.300	1.430	1.560	1.690	1.820	1.950	2.080	2.210	2.340	2.471	2.601	2.731	2 861	2.991	3.121	3.251	97
98	.1314	.2627	.3940	.5255	.6568	.7882	.9196	1.051	1.823	1.314	1.445	1.576	1.703	1.839	1.971	2.102	2.233	2.365	2.496	2 627	2.759	2.830	3.021	3.153	3.284	98
99	.1327	.2654	.3981	.5308	.6635	.7962	.9290	1.062	1.914	1.327	1.460	1.592	1.725	1 858	1.991	2.123	2.256	2.389	2.521	2.654	2.787	2.920	3.052	3.185	3.318	99
100	.1340	.2681	.4021	.5362	.6702	.8043	.9383	1.072	1.203	1.340	1.475	1.609	1.743	1.877	2.011	2.144	2.279	2.413	2 547	2.681	2.815	2.949	3.083	3.217	3.351	100
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	

VOLTS OR AMPERES.

VOLTS OR AMPERES.

AMPERES OR VOLTS.

TABLE OF ELECTRICAL HORSE POWERS.

Read ampères at top and volts at side, or *vice versa*.

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The formula which was used to obtain the figures in this table is

$$\frac{\text{Volts} \times \text{ampères}}{746} = \text{Elec. h. p.}$$

AMPERES OR VOLTS.

Volts or ampères.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Volts or ampères.
1	.0348	.0361	.0375	.0388	.0402	.0415	.0429	.0442	.0455	.0469	.0482	.0495	.0509	.0522	.0536	.0549	.0563	.0576	.0589	.0603	.0616	.0630	.0643	.0656	.0670	1
2	.0697	.0723	.0750	.0777	.0804	.0831	.0857	.0884	.0911	.0938	.0965	.0991	.1018	.1045	.1072	.1099	.1126	.1152	.1179	.1206	.1233	.1260	.1286	.1313	.1340	2
3	.1045	.1085	.1126	.1166	.1206	.1246	.1286	.1327	.1367	.1407	.1447	.1487	.1528	.1568	.1608	.1648	.1689	.1729	.1769	.1809	.1849	.1890	.1930	.1970	.2010	3
4	.1394	.1448	.1501	.1554	.1609	.1662	.1716	.1769	.1823	.1877	.1920	.1984	.2036	.2091	.2145	.2198	.2252	.2306	.2359	.2413	.2466	.252)	.2574	.2627	.2681	4
5	.1743	.1810	.1876	.1944	.2011	.2078	.2145	.2212	.2279	.2346	.2413	.2480	.2547	.2614	.2680	.2748	.2315	.2882	.2949	.3013	.3083	.3150	.3217	.3284	.3351	5
6	.2090	.2017	.2252	.2332	.2412	.2492	.2572	.2654	.2734	.2814	.2894	.2974	.3056	.3136	.3216	.3296	.3376	.3458	.3538	.3618	.3698	.3780	.3860	.3941	.4021	6
7	.2440	.2533	.2627	.2721	.2815	.2909	.3003	.3097	.3190	.3284	.3378	.3472	.3566	.3659	.3754	.3847	.3941	.4035	.4129	.4223	.4316	.4400	.4504	.4597	.4692	7
8	.2789	.2895	.3003	.3110	.3217	.3324	.3432	.3539	.3646	.3753	.3861	.3968	.4750	.4182	.4290	.4397	.4504	.4611	.4718	.4825	.4933	.5040	.5147	.5254	.5362	8
9	.3137	.3257	.3378	.3499	.361	.3740	.3861	.3981	.4102	.4223	.4343	.4464	.4584	.4705	.4825	.4946	.5067	.5188	.5308	.5429	.5550	.5670	.5791	.5915	.6032	9
10	.3485	.3619	.3753	.3887	.4021	.4155	.4290	.4424	.4557	.4692	.4826	.4960	.5094	.5228	.5362	.5495	.5630	.5724	.5898	.6032	.6166	.6300	.6434	.6568	.6702	10
11	.3834	.3981	.4129	.4276	.4424	.4571	.4718	.4868	.5013	.5161	.5308	.5456	.5603	.5751	.5898	.6046	.6193	.6340	.6488	.6635	.6783	.6930	.7078	.7226	.7373	11
12	.4182	.4343	.4504	.4665	.4826	.4987	.5147	.5308	.5470	.5330	.5991	.5952	.6113	.6273	.6134	.6595	.6756	.6917	.7078	.7239	.7399	.7560	.7721	.7882	.8043	12
13	.4431	.4706	.4879	.5054	.5227	.5402	.5576	.5751	.5925	.6099	.6273	.6448	.6622	.6795	.6971	.7145	.7319	.7493	.7668	.7842	.8016	.8190	.8365	.8539	.8713	13
14	.4879	.5067	.5254	.5442	.5630	.5818	.6005	.6193	.6381	.6568	.6756	.6944	.7131	.7319	.7517	.7649	.7892	.8070	.8257	.8445	.8633	.8820	.9008	.9196	.9383	14
15	.5227	.5429	.5630	.5831	.6032	.6233	.6434	.6635	.6836	.7038	.7239	.7440	.7641	.7842	.8043	.8244	.8495	.8646	.8847	.9048	.9249	.9450	.9651	.9853	1.005	15
16	.5576	.5791	.6005	.6220	.6434	.6649	.6863	.7078	.7292	.7507	.7721	.7936	.8150	.8365	.8579	.8794	.9008	.9223	.9437	.9651	.9866	1.008	1.029	1.051	1.072	16
17	.5924	.6015	.6380	.6609	.6836	.7064	.7292	.7520	.7748	.7976	.8204	.8432	.8660	.8887	.9115	.9343	.9571	.9799	1 003	1.025	1.048	1.071	1.094	1.117	1.139	17
18	.6273	.6515	.6756	.6997	.7239	.7480	.7721	.7962	.8204	.8445	.8686	.8928	.9169	.9410	.9651	.9893	1.013	1.038	1.062	1 086	1.110	1.134	1.158	1.182	1.206	18
19	.6621	.6877	.7131	.7386	.7641	.7895	.8150	.8405	.8660	.8914	.9'69	.9424	.9678	.9953	1.0.9	1.044	1.070	1.096	1.121	1.146	1.171	1.197	1.223	1.948	1.273	19
20	.6970	.7238	.7507	.7775	.8043	.8311	.8579	.8847	.9115	.9383	.9601	.9920	1.019	1.046	1.071	1 099	1.126	1.153	1.180	1.206	1.233	1.260	1.287	1.314	1.340	20
21	.7319	.7601	.7882	.8164	.8445	.8727	.9008	.9290	.9571	.9853	1.013	1.042	1.070	1.098	1,126	1.154	1.182	1.210	1.239	1.267	1.295	1 323	1.351	1.379	1.408	21
22	.7668	.7962	.8257	.8552	.8847	.9142	.9437	.9732	1.003	1.032	1.062	1.091	1.1?1	1,150	1.180	1.209	1.239	1.268	1.298	1.327	1.357	1.386	1.416	1.445	1.475	22
23	.8016	.8324	.8633	.8941	.9249	.9557	.9866	1.017	1.048	1.079	1.110	1.141	1.172	1.202	1.233	1.264	1.295	1.325	1.357	1.387	1.418	1.449	1.480	1.511	1.542	23
24	.8365	.8686	.9008	.9330	.9651	.9973	1.029	1.062	1.094	1.126	1.158	1.190	1.223	1.255	1.287	1.319	1.351	1.383	1.416	1.448	1.480	1.512	1.544	1.576	1.609	24
25	.8713	.9048	.9383	.9718	1.005	1.039	1.073	1.105	1.139	1.173	1.206	1.240	1.273	1.307	1.340	1.374	1.408	1.440	1.475	1.508	1.542	1.575	1.609	1.642	1.675	25
26	.9062	.9410	.9759	1.011	1.046	1.084	1.115	1.150	1.185	1.220	1.255	1.290	1.324	1.352	1.394	1.429	1.464	1.499	1.534	1.568	1.603	1.638	1.673	1.708	1.743	26
27	.9410	.9772	1.013	1.050	1.086	1.122	1.158	1.194	1.231	1.·67	1.303	1.339	1.375	1.412	1.448	1.484	1.520	1.556	1.592	1.629	1.665	1.701	1.737	1.773	1.810	27
28	.9759	1.013	1.051	1.088	1.126	1.164	1.201	1.239	1.276	1.314	1.351	1.389	1.426	1.464	1.501	1.539	1.576	1.614	1.651	1.689	1.726	1 764	1.802	1.839	1.877	28
29	1.011	1.050	1.088	1.127	1.166	1.205	1.244	1.283	1.322	1.351	1.399	1.438	1.477	1.516	1.555	1.594	1.633	1.672	1.710	1.749	1.788	1.827	1.863	1.905	1.944	29
30	1.046	1.086	1.126	1.166	1.206	1.247	1.287	1.327	1.367	1.408	1.448	1.488	1.528	1.568	1.609	1.649	1.699	1.729	1.769	1.810	1.850	1.890	1.930	1.971	2.011	30
31	1.084	1.122	1.164	1.205	1.247	1.288	1 330	1.371	1.413	1.454	1.496	1.538	1.579	1.621	1.662	1.704	1.745	1.787	1.828	1.870	1.912	1.953	1.995	2.036	2.078	31
32	1.115	1.158	1.201	1.244	1.287	1.330	1.373	1 416	1.458	1.501	1.544	1.587	1.630	1.673	1.716	1.759	1.802	1.845	1.887	1.930	1.973	2.016	2.059	2.102	2.145	32
33	1.150	1.194	1.239	1.287	1.327	1.371	1.416	1.460	1.504	1.548	1.592	1.637	1.681	1.725	1.769	1.814	1.858	1.902	1.946	1.991	2.035	2.079	2.123	2.168	2 212	33
34	1.185	1.231	1.276	1.322	1.367	1.413	1.458	1 504	1.550	1.595	1.611	1.686	1.732	1.777	1.823	1.869	1.914	1.960	2.005	2.051	2.097	2.142	2.188	2.233	2.279	34
35	1.220	1.267	1.314	1.362	1.408	1.454	1.501	1.548	1.595	1.642	1.689	1.736	1.783	1.830	1.877	1.924	1.971	2.017	2.034	2.111	2.158	2.205	2.252	2.299	2.346	35
36	1.255	1.303	1.351	1.399	1.447	1.496	1.544	1.592	1.641	1 689	1.737	1.786	1.834	1.882	1.930	1.979	2.027	2.075	2.123	2.172	2.220	2.268	2.316	2.365	2.413	36
37	1.290	1.339	1.389	1.438	1.488	1 538	1 587	1.637	1.686	1.736	1.785	1.835	1.885	1.934	1.984	2.034	2.083	2.133	2.182	2.232	2.282	2.331	2.381	2.430	2 480	37
38	1.324	1.375	1.426	1.477	1.528	1.579	1.630	1.681	1.732	1.783	1.834	1.885	1.936	1 987	2.038	2.088	2.139	2.190	2.241	2.292	2.343	2.394	2.445	2.496	2.547	38
39	1.359	1.412	1.464	1.516	1.568	1.621	1.673	1.725	1.777	1 830	1.882	1.934	1.987	2.039	2.091	2.143	2.196	2.248	2.300	2.353	2.405	2.457	2.509	2.562	2.614	39
40	1.394	1.448	1.501	1 555	1.609	1.662	1.716	1.739	1.823	1.877	1.930	1.934	2.038	2.091	2.115	2.198	2.252	2.306	2.359	2.413	2.466	2.520	2.574	2.627	2.681	40
41	1.429	1.484	1.539	1.594	1.649	1.704	1.759	1.814	1.869	1.924	1.979	2.034	2.088	2.143	2.198	2.253	2.308	2.363	2.418	2.473	2.528	2.583	2 638	2.693	2.748	41
42	1.464	1.520	1.576	1.633	1.699	1.745	1.802	1.858	1.914	1.971	2.027	2.083	2.139	2.196	2.252	2.308	2.365	2.421	2.477	2.534	2.590	2.646	?.702	2.759	2.815	42
43	1.499	1.556	1.613	1.672	1.729	1.787	1.845	1.902	1.960	2.017	2.075	2.133	2.190	2.248	2.306	2.363	2.421	2.479	2.536	2.594	2.651	2 709	2.767	2 824	2.882	43
44	1.534	1.592	1.651	1.710	1.769	1.828	1.887	1.946	2.005	2.064	2.123	2.182	2.241	2.300	2.359	2.418	2 477	2.536	2.595	2.654	2.713	2.772	2.831	2.890	2.949	44
45	1.568	1.628	1.689	1.749	1.810	1.870	1.930	1.991	2.051	2.111	2.172	2.232	2.292	2.353	2.413	2.473	2.534	2.594	2.654	2.714	2.775	2.835	2.895	2.956	3.016	45
46	1.603	1.665	1.727	1.788	1.850	1.912	1.973	2.035	2.097	2.158	2.220	2.282	2.343	2.405	2.466	2.528	2.590	2.651	2.713	2.775	2.836	2.898	2.960	3.021	3.083	46
47	1.638	1.701	1.764	1.827	1.890	1.953	2.016	2.079	2.142	2.205	2.268	2.331	2.394	2.457	2.520	2.583	2.646	2.709	2.772	2.835	2.898	2.961	3.024	3.087	3.150	47
48	1.673	1.737	1.802	1.866	1.930	1.995	2.059	2.123	2.188	2.252	2 316	2.381	2.445	2.509	2.574	2.638	2 702	2.767	2.831	2.895	2.960	3.024	3.088	3.153	3.217	48
49	1.708	1.773	1.840	1.905	1.971	2.036	2.102	2.168	2.233	2.299	2 365	2.430	2.496	2.562	2.627	2.693	2.759	2.824	2.890	2.956	3.021	3.087	3.153	3.218	3 284	49
50	1.743	1.810	1.877	1.944	2.011	2.078	2.145	2.211	2.279	2.346	2.413	2.480	2.547	2.614	2.681	2.748	2.815	2.882	2.949	3.016	3.083	3.150	3.217	3 284	3.351	50
51	1.777	1.846	1.914	1.983	2.051	2.119	2.188	2.256	2.324	2.393	2.461	2.529	2.598	2.666	2.735	2.803	2.871	2.940	3.008	3.076	3.145	3.213	3.282	3.350	3.418	51
52	1.812	1.882	1.952	2.021	2.091	2.161	2.231	2.300	2.370	2.440	2.509	2.579	2.689	2 718	2.788	2.858	2.928	2.997	3.067	3.137	3.206	3.276	3.346	3.416	3.485	52
53	1.847	1.918	1.989	2.060	2.131	2.202	2.273	2.345	2.416	2 487	2.558	2.629	2 700	2.771	2.842	2.913	2.984	3.055	3.126	3.197	3.268	3.339	3.410	3.481	3.552	53
54	1.882	1.954	2.027	2.099	2.172	2.244	2.316	2.389	2.461	2.534	2.606	2.678	2.751	2.823	2.895	2.968	3.040	3.113	3.185	3.257	3.330	3.402	3.475	3.547	3 619	54
55	1.917	1.991	2.064	2.138	2.212	2.286	2.359	2.433	2.507	2 580	2.654	2.728	2.802	2.875	2.949	3.023	3.097	3.160	3.244	3.318	3.391	3.465	3.539	3 613	3.686	55
56	1.952	2.027	2.102	2.177	2.252	2.327	2.402	2 477	2.552	2.627	2.702	2.777	2.853	2.928	3.003	3.078	3.153	3.228	3.303	3.378	3.453	3.528	3.603	3.678	3.753	56
57	1.987	2.063	2.139	2.216	2.292	2.369	2.445	2.521	2.598	2.674	2.751	2.827	2.903	2.980	3.056	3.133	3.209	3.286	3.362	3.438	3.515	3.591	3.668	3.744	3.820	57
58	2.021	2.099	2.177	2.255	2.332	2.410	2.488	2.566	2.643	2.721	2.799	2.877	2.954	3.022	3.110	3.188	3.265	3.313	3.421	3.499	3.576	3.654	3.732	3.810	3.887	58
59	2 056	2.135	2.214	2.294	2.373	2.452	2.531	2.610	2.689	2.768	2.847	2.926	3.005	3.074	3.164	3.243	3.322	3.401	3.480	3.559	3.638	3 717	3.796	3.875	3.954	59
60	2.091	2.172	2.252	2.332	2.413	2.493	2.574	2.654	2.735	2.815	2.895	2.976	3.056	3.137	3.217	3.298	3.378	3.458	3.539	3.619	3.700	3 780	3 861	3.941	4.021	60
61	2.126	2.208	2.290	2.371	2.453	2.535	2.617	2.698	2.780	2.862	2.944	3.025	3.107	3.189	3.271	3 353	3.434	3.516	3.598	3.680	3.761	3 843	3.925	4.007	4.088	61
62	2.161	2.244	2.327	2.410	2 493	2.576	2.660	2.743	2.826	2.909	2.992	3.075	3.158	3 241	3.324	3.408	3.491	3.574	3.657	3.740	3.823	3.906	3.989	4.072	4.155	62
63	2.196	2.280	2 365	2.449	2.534	2.619	2.702	2.787	2.871	2.956	3.040	3.125	3.209	3.294	3.378	3.462	3.547	3.631	3.716	3.809	3.885	3.969	4.054	4.138	4.223	63
64	2.231	2.316	2.402	2.488	2.574	2.660	2.745	2.831	2.917	3.003	3.088	3.174	3.260	3.316	3.432	3.517	3.603	3.689	3.775	3.861	3 946	4.032	4.118	4.204	4.290	64
65	2.265	2.353	2.440	2.527	2.614	2.701	2.788	2.875	2.932	3.050	3.137	3.224	3.311	3 398	3.485	3.572	3.660	3.747	3.834	3.921	4.008	4.095	4.182	4.269	4.357	65
66	2.300	2.389	2.477	2.566	2.654	2.743	2.831	2.920	3.008	3.097	3.185	3.273	3.362	3.450	3.539	3.627	3.716	3.804	3.893	3.981	4.070	4.158	4.247	4.335	4.424	66
67	2.335	2.495	2.515	2.605	2.694	2 784	2.874	2 964	3.054	3.143	3.233	3.323	3.413	3.503	3.592	3.682	3.772	3.862	3.952	4.042	4.131	4.221	4.311	4.401	4.491	67
68	2.370	2.461	2.552	2.643	2.735	2.826	2.917	3.008	3.099	3.190	3.282	3.373	3.464	3.555	3.646	3.737	3.828	3.920	4.011	4.102	4.193	4.284	4.375	4.466	4.558	68
69	2.405	2.497	2.590	2.682	2.775	2.867	2.960	3.052	3.145	3.237	3.330	3.422	3.515	3.607	3.700	3.792	3.885	3.977	4.070	4.162	4.255	4.347	4.440	4.532	4.625	69
70	2.440	2.534	2.627	2.724	2.815	2.909	3.003	3.097	3.190	3.284	3.378	3.472	3.565	3.660	3.753	3.847	3.941	4.035	4.129	4.223	4.316	4.410	4.504	4.598	4.692	70
71	2.475	2.570	2.665	2.760	2.855	2.950	3.046	3.141	3.236	3.331	3.426	3.521	3.617	3.712	3.807	3.902	3.997	4.093	4.188	4.283	4.378	4.473	4.568	4.664	4.759	71
72	2.509	2.606	2 702	2.799	2.895	2.992	3.088	3.185	3.282	3.378	3.475	3.571	3.668	3.764	3.861	3.957	4.054	4.150	4.247	4.343	4.440	4.536	4 633	4.729	4.826	72
73	2.544	2.642	2.740	2.838	2.936	3.034	3.131	3.229	3.327	3.425	3.523	3.621	3.718	3.816	3.914	4.012	4.110	4.208	4.306	4.403	4.501	4.599	4.697	4.795	4.893	73
74	2.579	2.678	2.777	2.877	2.976	3.075	3.174	3.273	3.373	3.472	3.571	3.670	3.769	3 869	3.968	4.067	4.166	4.265	4.365	4.464	4.563	4.662	4.761	4.861	4.961	74
75	2.614	2.714	2.815	2.916	3.016	3.117	3.217	3.3.8	3.418	3.519	3.619	3.720	3.820	3.921	4.024	4.122	4.223	4.323	4.424	4.524	4.625	4.725	4.826	4.926	5.027	75
76	2.649	2.751	2.853	2.954	3.056	3.158	3.260	3.362	3.464	3.566	3.668	3.769	3 871	3.973	4.075	4.177	4.279	4.381	4.483	4.584	4.686	4.788	4.890	4.992	5.094	76
77	2.684	2.787	2.890	2.993	3.097	3 200	3.303	3.406	3.509	3.613	3.716	3.819	3.922	4.025	4.129	4.232	4.335	4.438	4.542	4 645	4.748	4.851	4.954	5.058	5.161	77
78	2.718	2.823	2.928	3.032	3.137	3.241	3.346	3.450	3.555	3.660	3.764	3.869	3.973	4.078	4.182	4.287	4.391	4.496	4.601	4.705	4.810	4.914	5.019	5.123	5.228	78
79	2.753	2.859	2.965	3.071	3.177	3.283	3.389	3.495	3.601	3 706	3.812	3.918	4.024	4.130	4.236	4.342	4.448	4.554	4.660	4.765	4.871	4.977	5.083	5.189	5.295	79
80	2.788	2.895	3.002	3.110	3.217	3.324	3.432	3.539	3.646	3.753	3.861	3.968	4.075	4.182	4.290	4.397	4.504	4.611	4.718	4.826	4.933	5.040	5.147	5.255	5.362	80
81	2.823	2.932	3.040	3.149	3.257	3.366	3.475	3.583	3.692	3.800	3.909	4.017	4.127	4.235	4.343	4.452	4.560	4.669	4.777	4.886	4.995	5.103	5.212	5.320	5.429	81
82	2.858	2.968	3.078	3.188	3.298	3.408	3.517	3.627	3.737	3.847	3.957	4.067	4.177	4.287	4 397	4.507	4.617	4.727	4.836	4.946	5.056	5.166	5.276	5.386	5.496	82
83	2.893	3.004	3.115	3.227	3.338	3.449	3.560	3.672	3.783	3.894	4.005	4.117	4.228	4.339	4.450	4.562	4.673	4.784	4.895	5.007	5.118	5.229	5.340	5.452	5.563	83
84	2.928	3.040	3.153	3.265	3.378	3.491	3.603	3.716	3.828	3.941	4.054	4.166	4.279	4 391	4.504	4.617	4.729	4.842	4.954	5.067	5.180	5.292	5.405	5.517	5.630	84
85	2.962	3.076	3.190	3.304	3.418	3 532	3.646	3.760	3.874	3.988	4.102	4.216	4.330	4.444	4.558	4.672	4.786	4.899	5.013	5.127	5.241	5.355	5.469	5.583	5.697	85
86	2.997	3.113	3 228	3.343	3.458	3 574	3.689	3.804	3.920	4.035	4.150	4 265	4.381	4.496	4.611	4.727	4.842	4.957	5.072	5.188	5.303	5.418	5.534	5.649	5.764	86
87	3.032	3.149	3.265	3 382	3.499	3.615	3.732	3.849	3.965	4.082	4.198	4.315	4.432	4.548	4.665	4.782	4.898	5.015	5.131	5.248	5.365	5.481	5.598	5.714	5.831	87
88	3.067	3.185	3.303	3.421	3.539	3.657	3.775	3.893	4.011	4.129	4.247	4.365	4.483	4 601	4.718	4.836	4.954	5.072	5.190	5.308	5.426	5.544	5.662	5.780	5.898	88
89	3.102	3.221	3.340	3.460	3.579	3.698	3.818	3.937	4.056	4 176	4.295	4.414	4.534	4.653	4.772	4.891	5.011	5 120	5.249	5.369	5.488	5.607	5.727	5.846	5.965	89
90	3.137	3.257	3.378	3.499	3.619	3.740	3 861	3.981	4.102	4.223	4.343	4.464	4.584	4.705	4.825	4.946	5.067	5.188	5 308	5.429	5.550	5.670	5.791	5.912	6.032	90
91	3.172	3.294	3.416	3.538	3.660	3.782	3.903	4.025	4.147	4.269	4.391	4.513	4.635	4.757	4.879	5.001	5.123	5.245	5.367	5.489	5.611	5.733	5.855	5.977	6.099	91
92	3.206	3.330	3.453	3 576	3.700	3.823	3.946	4.070	4.193	4,316	4.440	4 563	4 686	4.810	4.933	5.056	5.180	5.303	5.426	5.550	5.673	5.796	5.920	6.043	6.166	92
93	3.241	3.366	3.491	3.615	3.740	3.865	3.989	4.114	4.239	4.363	4.488	4.613	4.737	4.862	4.987	5.111	5.236	5.360	5.485	5.610	5.735	5.859	5.984	6.109	6.233	93
94	3.276	3.402	3.528	3.654	3.780	3.906	4.032	4.158	4.284	4.410	4.536	4 662	4.788	4.914	5.040	5.166	5.292	5.418	5.544	5.670	5.797	5.922	6.048	6.174	6.300	94
95	3.311	3.438	3.566	3.693	3.820	3.948	4.075	4.202	4.330	4.457	4.584	4.712	4.839	4.966	5.094	5.221	5.349	5.476	5.603	5.731	5.858	5.985	6.113	6.240	6.367	95
96	3.346	3.475	3.603	3.732	3 861	3.989	4.118	4.247	4.375	4.504	4.633	4 761	4.890	5.019	5.147	5.276	5.405	5.533	5.662	5.791	5.920	6.048	6.177	6.306	6.434	96
97	3.381	3.511	3.641	3.771	3.901	4.031	4.161	4.291	4.421	4.551	4.681	4.811	4.941	5.071	5.201	5.331	5.461	5.591	5.721	5.851	5.981	6.111	6.241	6.371	6.501	97
98	3.416	3.547	3.678	3.810	3.941	4.072	4.204	4.335	4 466	4.598	4.729	4.861	4.992	5.123	5.255	5.386	5.517	5.649	5.780	5.912	6.043	6.174	6 306	6 437	6.568	98
99	3.451	3.583	3.716	3.849	3.981	4.114	4.247	4.379	4.512	4.645	4.777	4.910	5.043	5.176	5.308	5.441	5.574	5.706	5.839	5.972	6 105	6.237	6.370	6.503	6.635	99
100	3.485	3.619	3.753	3.887	4.021	4.155	4.290	4.424	4.558	4.692	4.826	4.960	5 094	5.228	5.362	5.495	5.630	5.764	5.898	6.032	6.166	6.300	6.434	6.568	6.702	100
	26	27	28	29	30	31	32	33	34	35	36	37	38

TABLE OF ELECTRICAL HORSE POWERS.

Read volts at top and ampères at side, or *vice versa*.

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The formula which was used to obtain the figures in this table is

$$\frac{\text{Volts} \times \text{ampères}}{746} = \text{Elec. h. p.}$$

AMPERES OR VOLTS.

VOLTS OR AMPERES.

Volts or ampères.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Volts or ampères.
101	.1354	.2708	.4062	.5416	.6769	.8123	.9477	1.083	1.218	1.354	1.489	1.625	1.760	1.895	2.031	2.166	2.302	2.437	2.572	2.708	2.843	2.979	3.114	3.250	3.385	101
102	.1367	.2735	.4102	.5470	.6836	.8204	.9571	1.094	1.231	1.367	1.504	1.641	1.777	1.914	2.051	2.188	2.324	2.461	2.598	2.735	2.871	3.008	3.145	3.282	3.418	102
103	.1381	.2761	.4142	.5523	.6903	.8284	.9665	1.105	1.243	1.381	1.519	1.657	1.795	1.933	2.071	2.209	2.347	2.485	2.623	2.761	2.900	3.038	3.176	3.314	3.452	103
104	.1394	.2788	.4182	.5576	.6971	.8365	.9759	1.115	1.255	1.394	1.534	1.673	1.812	1.952	2.091	2.231	2.370	2.509	2.649	2.788	2.928	3.067	3.206	3.343	3.485	104
105	.1408	.2815	.4223	.5630	.7038	.8445	.9853	1.126	1.267	1.408	1.548	1.689	1.830	1.971	2.111	2.252	2.393	2.534	2.674	2.815	2.956	3.097	3.237	3.378	3.519	105
106	.1421	.2842	.4263	.5684	.7105	.8525	.9946	1.137	1.279	1.421	1.563	1.705	1.847	1.989	2.131	2.273	2.416	2.558	2.700	2.842	2.984	3.126	3.268	3.410	3.552	106
107	.1434	.2869	.4303	.5737	.7172	.8606	1.004	1.147	1.291	1.434	1.578	1.721	1.865	2.008	2.151	2.295	2.438	2.582	2.725	2.869	3.012	3.155	3.299	3.442	3.586	107
108	.1448	.2895	.4343	.5791	.7239	.8686	1.013	1.158	1.303	1.448	1.592	1.737	1.882	2.027	2.172	2.316	2.461	2.606	2.751	2.895	3.040	3.185	3.330	3.475	3.619	108
109	.1461	.2922	.4383	.5845	.7306	.8767	1.023	1.169	1.315	1.461	1.607	1.753	1.899	2.046	2.192	2.338	2.484	2.630	2.776	2.922	3.068	3.214	3.361	3.507	3.653	109
110	.1475	.2949	.4423	.5898	.7372	.8847	1.032	1.180	1.327	1.475	1.622	1.769	1.917	2.064	2.212	2.359	2.507	2.650	2.802	2.949	3.097	3.244	3.391	3.539	3.686	110
111	.1488	.2976	.4464	.5952	.7440	.8928	1.042	1.190	1.339	1.488	1.637	1.786	1.934	2.083	2.232	2.381	2.529	2.678	2.827	2.976	3.125	3.273	3.422	3.571	3.720	111
112	.1501	.3003	.4504	.6005	.7504	.9008	1.051	1.201	1.351	1.501	1.651	1.802	1.952	2.102	2.252	2.402	2.552	2.702	2.853	3.003	3.153	3.303	3.453	3.603	3.753	112
113	.1515	.3029	.4544	.6059	.7574	.9088	1.060	1.212	1.363	1.515	1.666	1.818	1.969	2.121	2.272	2.424	2.575	2.727	2.878	3.029	3.181	3.332	3.484	3.635	3.787	113
114	.1528	.3056	.4584	.6113	.7641	.9169	1.070	1.223	1.375	1.528	1.681	1.834	1.987	2.139	2.292	2.445	2.598	2.751	2.903	3.056	3.209	3.362	3.515	3.668	3.820	114
115	.1542	.3083	.4625	.6163	.7708	.9249	1.079	1.233	1.387	1.542	1.695	1.850	2.004	2.158	2.312	2.466	2.621	2.775	2.929	3.083	3.237	3.391	3.546	3.700	3.854	115
116	.1555	.3110	.4665	.6220	.7775	.9330	1.088	1.244	1.400	1.555	1.710	1.866	2.021	2.177	2.332	2.488	2.643	2.799	2.954	3.110	3.265	3.421	3.576	3.732	3.887	116
117	.1568	.3137	.4705	.6273	.7842	.9410	1.098	1.255	1.412	1.568	1.725	1.882	2.039	2.196	2.353	2.509	2.666	2.823	2.980	3.137	3.294	3.450	3.607	3.764	3.921	117
118	.1582	.3164	.4745	.6327	.7909	.9491	1.107	1.265	1.424	1.582	1.740	1.898	2.056	2.214	2.373	2.531	2.689	2.847	3.005	3.164	3.322	3.480	3.638	3.796	3.954	118
119	.1595	.3190	.4786	.6381	.7976	.9571	1.117	1.276	1.436	1.595	1.755	1.914	2.074	2.233	2.393	2.552	2.712	2.871	3.021	3.190	3.350	3.509	3.669	3.828	3.988	119
120	.1609	.3217	.4825	.6434	.8043	.9651	1.126	1.287	1.448	1.609	1.769	1.930	2.091	2.252	2.413	2.574	2.735	2.895	3.056	3.217	3.378	3.539	3.700	3.861	4.021	120
121	.1622	.3244	.4866	.6488	.8110	.9732	1.135	1.298	1.460	1.622	1.784	1.946	2.107	2.271	2.433	2.595	2.757	2.916	3.082	3.244	3.406	3.568	3.731	3.893	4.055	121
122	.1635	.3271	.4906	.6542	.8177	.9812	1.147	1.308	1.472	1.635	1.799	1.962	2.126	2.290	2.453	2.617	2.780	2.943	3.107	3.271	3.434	3.598	3.761	3.925	4.088	122
123	.1649	.3296	.4946	.6595	.8244	.9893	1.154	1.319	1.484	1.649	1.814	1.979	2.143	2.308	2.473	2.638	2.803	2.968	3.133	3.298	3.462	3.627	3.792	3.957	4.122	123
124	.1662	.3324	.4987	.6649	.8311	.9973	1.164	1.330	1.496	1.662	1.828	1.995	2.161	2.327	3.493	2.660	2.826	2.992	3.158	3.324	3.491	3.657	3.823	3.990	4.155	124
125	.1676	.3351	.5027	.6702	.8378	1.005	1.173	1.340	1.508	1.676	1.843	2.011	2.178	2.346	2.513	2.681	2.849	3.016	3.184	3.351	3.519	3.686	3.854	4.021	4.189	125
126	.1689	.3378	.5067	.6756	.8445	1.013	1.182	1.351	1.520	1.689	1.858	2.027	2.193	2.365	2.534	2.702	2.871	3.040	3.207	3.378	3.547	3.716	3.885	4.054	4.223	126
127	.1702	.3405	.5107	.6810	.8512	1.021	1.192	1.362	1.532	1.702	1.873	2.043	2.213	2.383	2.554	2.724	2.891	3.064	3.235	3.405	3.575	3.745	3.916	4.086	4.256	127
128	.1716	.3432	.5147	.6863	.8579	1.029	1.201	1.373	1.544	1.716	1.887	2.059	2.231	2.402	2.574	2.745	2.917	3.088	3.260	3.432	3.603	3.775	3.945	4.118	4.290	128
129	.1729	.3458	.5188	.6917	.8646	1.038	1.210	1.383	1.556	1.729	1.902	2.075	2.248	2.421	2.591	2.767	2.940	3.113	3.286	3.458	3.631	3.804	3.972	4.150	4.323	129
130	.1743	.3485	.5227	.6970	.8713	1.046	1.220	1.394	1.568	1.743	1.917	2.091	2.265	2.440	2.614	2.788	2.962	3.137	3.311	3.485	3.660	3.834	4.008	4.182	4.357	130
131	.1756	.3512	.5268	.7024	.8780	1 054	1 229	1.405	1.580	1.756	1.932	2.107	2.283	2.458	2.634	2.810	2.985	3.161	3.346	3.512	3.688	3.863	4.039	4.214	4.390	131
132	.1769	.3539	.5308	.7078	.8847	1.062	1.239	1.416	1.592	1.769	1.946	2.123	2.300	2.477	2.654	2.831	3.008	3.185	3.362	3.539	3.716	3.893	4.070	4.247	4.424	132
133	.1783	.3566	.5349	.7131	.8914	1.070	1.248	1.426	1.605	1.783	1.961	2.139	2.318	2.496	2.674	2.853	3.031	3.209	3.387	3.566	3.744	3.922	4.100	4.279	4.457	133
134	.1796	.3592	.5389	.7185	.8961	1.078	1.257	1.437	1.617	1.796	1.976	2.155	2.335	2.515	2.694	2.874	3.054	3.233	3.413	3.592	3.772	3.952	4.131	4.311	4.491	134
135	.1810	.3619	.5429	.7239	.9048	1.086	1.267	1.448	1.629	1.810	1.991	2.172	2.353	2.534	2.714	2.895	3.076	3.257	3.438	3.619	3.800	3.981	4.162	4.343	4.524	135
140	.1877	.3753	.5630	.7506	.9383	1.126	1.314	1.501	1.689	1.877	2 064	2.252	2 440	2.627	2.815	3.003	3.190	3.378	3.566	3.753	3.941	4.129	4.316	4.502	4.692	140
145	.1944	.3887	.5831	.7775	.9718	1.166	1.360	1.555	1.749	1.944	2.138	2.332	2.527	2.721	2.916	3.110	3.304	3.499	3 693	3.887	4.082	4.276	4.471	4.665	4.859	145
150	.2011	.4021	.6032	.8043	1.005	1.206	1.408	1.609	1.810	2.011	2.212	2 413	2 614	2.815	3.016	3.217	3.418	3.619	3.820	4.021	4.223	4.424	4.625	4.825	5.027	150
155	.2078	.4156	.6233	.8311	1.039	1.247	1.454	1.662	1.870	2.078	2.286	2.493	2.701	2.909	3.117	3.324	3.532	3.740	3.948	4.156	4.363	4.571	4.779	4.987	5.194	155
160	.2145	.4289	.6431	.8579	1.072	1.287	1.501	1.713	1.930	2.145	2.360	2.574	2.788	3.003	3.217	3.432	3.646	3.861	4.075	4.290	4.504	4.718	4 933	5.147	5.362	160
165	.2212	.4424	.6635	.8847	1.106	1.327	1.548	1.769	1.991	2.212	2.433	2.654	2.875	3.097	3.318	3.539	3.760	3 981	4.202	4.424	4.645	4.866	5.087	5.308	5.530	165
170	.2279	.4557	.6836	.9115	1.140	1.367	1.595	1.823	2.051	2.279	2.507	2.735	2.962	3.190	3.418	3.646	3.874	4.102	4.330	4.558	4.786	5.013	5.241	5.469	5.697	170
175	.2346	.4692	.7038	.9383	1.173	1.408	1.642	1.877	2.111	2.346	2 580	2.815	3.050	3.284	3.519	3.753	3.988	4.223	4.457	4.697	4.926	5.161	5.395	5.630	5.865	175
180	.2413	.4825	.7238	.9651	1.206	1.448	1.689	1.930	2.172	2.413	2.654	2.895	3.137	3.378	3.619	3.861	4.102	4.313	4.584	4.826	5.061	5.308	5.550	5.791	6 032	180
185	.2480	.4960	.7440	.9920	1.240	1.488	1.736	1.984	2.232	2.480	2.728	2.976	3.224	3.472	3.720	3.968	4.216	4.464	4.712	4.960	5.208	5.456	5.704	5.952	6 200	185
190	.2546	.5094	.7640	1.019	1.273	1.528	1.783	2.038	2.292	2.547	2 802	3.056	3.311	3.566	3.820	4.075	4.330	4.584	4.839	5.094	5.349	5.603	5.858	6.113	6.3672	190
195	.2614	.5228	.7842	1.046	1.307	1.568	1.830	2.091	2.353	2.614	2 875	3.137	3.398	3.660	3.920	4.182	4 444	4.705	4.966	5.228	5.489	5.751	6.012	6.273	6.535	195
200	.2680	.5361	.8042	1.072	1.340	1.609	1.877	2.148	2.413	2.681	2.949	3.217	3.485	3.753	4.021	4.290	4.558	4.826	5.094	5.362	5.630	5.898	6.166	6.434	6.702	200
205	.2748	.5495	.8243	1.099	1.374	1.649	1.924	2.198	2.473	2.748	3.023	3.298	3.572	3.847	4.122	4.397	4.672	4.946	5.221	5.496	5.771	6.046	6.320	6.595	6 870	205
210	.2815	.5630	.8445	1.126	1.408	1.689	1.971	2.252	2 563	2.815	3.097	3.378	3.660	3.941	4.223	4.504	4.786	5.067	5.349	5.630	5.912	6.193	6.475	6.756	7.038	210
215	.2882	.5764	.8646	1.153	1.441	1.729	2.017	2.306	2.594	2.882	3.170	3.459	3.747	4.035	4.323	4.611	4.899	5.188	5.476	5.764	6.052	6.340	6.629	6.917	7 205	215
220	.2949	.5898	.8847	1.180	1.475	1.769	2.064	2.359	2.654	2.949	3.244	3.539	3.834	4.129	4.424	4.718	5.013	5.308	5.603	5.898	6.193	6.488	6 783	7.078	7.373	220
225	.3016	.6032	.9048	1.206	1.508	1.810	2.111	2.413	2.714	3.016	3.318	3.619	3 921	4 223	4.524	4.826	5.127	5.428	5.730	6.032	6.334	6.635	6.937	7.239	7.540	225
230	.3083	.6166	.9249	1.233	1.542	1.850	2.158	2.466	2.775	3.083	3.391	3.700	4 008	4.316	4.625	4.933	5.241	5.550	5.858	6.166	6.475	6.783	7.091	7.399	7.777	230
235	.3150	.6300	.9450	1.260	1.575	1.890	2.200	2.520	2.835	3.150	3 465	3.780	4.095	4.400	4.725	5.040	5.355	5.670	5.985	6.300	6.615	6.930	7.245	7.560	7.875	235
240	.3217	.6434	.9651	1.287	1.609	1.930	2.252	2 574	2.895	3.217	3.539	3.861	4 182	4.504	4.825	5.147	5.469	5.791	6 113	6.434	6.756	7.078	7.399	7.721	8.043	240
245	.3284	.6568	.9852	1.314	1.642	1 971	2.299	2.627	2.956	3.284	3.613	3.941	4.269	4.598	4 926	5.255	5.583	5.912	6.240	6.568	6.897	7.226	7.554	7.882	8.210	245
250	.3351	.6702	1.0053	1.340	1.676	2.011	2.346	2.681	3.016	3.351	3.686	4.021	4.357	4.692	5.027	5.362	5.697	6.032	6.367	6.702	7.038	7.373	7.708	8.043	8.378	250
255	.3418	.6836	1.025	1 367	1.709	2.051	2.393	2.735	3.076	3.418	3.760	4.102	4.444	4.786	5.127	5.469	5.811	6.153	6.495	6.836	7.178	7.520	7.862	8.204	8.546	255
260	.3185	.6970	1.046	1.394	1.743	2.091	2.440	2.788	3.137	3.485	3.834	4.182	4.531	4.879	5.228	5.576	5.925	6.273	6.622	6.971	7 320	7.668	8.016	8.365	8.713	260
265	.3552	.7104	1.066	1.421	1.776	2.131	2.487	2.842	3.197	3.552	3.9 8	4.263	4.618	4 973	5.328	5.684	6.039	6.394	6.749	7.105	7.460	7.815	8.170	8.525	8.881	265
270	.3619	.7238	1.086	1.448	1.810	2.172	2 534	2.895	3.257	3.619	3.981	4.343	4.706	5.067	5.429	5.791	6.153	6.515	6.877	7.239	7.601	7.962	8.324	8.686	9.048	270
275	.3686	.7373	1.106	1.475	1.843	2.212	2 580	2.949	3.318	3.686	4.055	4.424	4.792	5.161	5.530	5.898	6.267	6.635	7.004	7.373	7.741	8.110	8.478	8.847	9.216	275
280	.3753	.7506	1.126	1.501	1.877	2.252	2.627	3.003	3.378	3.753	4.128	4.504	4.879	5.275	5.630	6.005	6.381	6.756	7.131	7.507	7.882	8.257	8.633	9.008	9.383	280
285	.3820	.7641	1.146	1.528	1.910	2.292	2.674	3.056	3.438	3.820	4.202	4 584	4.966	5.349	5.731	6.113	6.495	6.877	7.259	7.641	8.023	8.405	8.787	9.169	9.551	285
290	.3887	.7775	1.166	1.555	1.944	2.332	2.721	3.110	3.499	3 887	4.276	4.665	5.054	5.442	5.831	6.220	6.609	6.997	7.386	7.775	8.164	8.552	8.941	9.330	9.718	290
295	.3954	.7909	1 186	1.582	1.977	2.373	2.768	3.164	3.559	3.954	4.350	4.745	5.141	5.536	5.932	6.327	6.723	7.118	7.513	7.909	8.304	8.700	9.095	9.491	9.886	295
300	.4021	.8043	1.206	1.609	2.011	2.413	2.815	3.217	3.619	4.021	4.424	4.826	5.228	5.630	6.032	6.434	6.836	7.239	7.641	8.043	8.445	8.847	9.249	9.651	10.05	300
310	.4155	.8311	1.247	1.662	2.078	2.493	2.909	3.324	3.740	4.155	4.571	4.987	5.402	5.818	6.233	6.649	7.064	7.480	7.895	8.311	8.727	9.142	9.558	9.973	10.39	310
320	.4289	.8579	1.287	1 716	2.145	2.574	3.003	3.432	3.861	4.290	4.718	5.147	5.576	6.005	6.434	6.863	7.292	7.721	8.150	8.579	9.008	9.457	9.866	10.29	10.72	320
330	.4423	.8847	1.327	1.769	2.212	2.654	3.097	3.539	3.981	4.424	4.868	5.308	5.751	6.193	6.635	7.078	7.520	7.962	8.405	8.847	9.290	9.732	10.17	10.62	11.06	330
340	.4557	.9115	1.367	1.823	2.279	2.735	3.190	3.646	4.102	4.558	5.013	5.469	5.925	6.381	6.836	7.292	7.748	8.204	8.660	9.115	9.571	10.03	10.48	10.94	11.39	340
350	.4691	.9383	1.408	1.877	2.346	2.815	3.284	3.753	4.223	4.692	5.161	5.630	6.099	6.568	7.038	7.507	7.976	8.445	8.914	9.383	9.853	10.32	10.79	11.26	11.73	350
360	.4825	.9601	1.448	1.920	2.413	2.895	3.378	3.861	4.343	4.826	5.308	5.791	6.273	6.756	7.239	7.721	8.204	8.686	9.169	9.601	10.13	10.62	11.10	11.58	12.06	360
370	.4959	.9919	1 488	1.984	2.480	2.975	3.472	3.968	4.464	4.960	5.456	5.952	6.448	6.944	7.440	7.936	8.432	8.928	9.423	9.920	10.42	10 91	11.41	11.90	12.40	370
380	.5094	1.019	1.528	2.038	2.547	3.056	3.566	4.075	4.584	5.094	5.603	6.113	6.622	7.131	7.641	8.150	8.660	9.169	9.678	10.19	10.70	11.21	11.72	12.23	12.73	380
390	.5227	1.046	1.568	2.091	2.614	3.137	3.659	4.182	4.705	5.228	5.751	6.273	6.796	7.319	7.842	8.365	8.887	9.410	9.933	10.46	10.98	11.50	12.02	12.55	13.07	390
400	.5361	1.072	1.602	2.145	2.681	3.217	3.753	4.290	4.825	5.362	5.898	6.434	6.971	7.507	8.043	8.580	9.115	9.651	10.19	10.71	11.26	11.80	12.33	12.87	13.40	400
410	.5495	1.099	1.648	2.198	2.748	3.298	3.847	4.397	4.946	5.495	6.046	6.596	7.145	7.694	8.244	8.794	9.343	9.893	10.44	10.99	11.54	12.09	12.64	13.19	13.74	410
420	.5630	1.126	1.699	2.252	2.815	3.378	3.941	4.504	5.067	5.630	6 193	6.756	7.319	7.882	8.495	9.008	9.571	10.13	10.70	11.26	11.82	12.39	12.95	13.51	14.08	420
430	.5764	1.153	1.729	2.306	2.882	3.458	4 035	4.611	5.188	5.764	6.340	6.917	7.493	8 070	8.646	9.223	9.799	10.38	10.95	11.53	12.10	12.68	13.26	13.83	14.41	430
440	.5898	1.180	1.769	2.359	2.949	3.539	4.129	4.718	5.308	5.898	6.488	7.078	7.668	8.251	8.847	9.437	10.03	10.62	11.21	11.80	12.39	12.98	13.57	14.16	14.75	440
450	.6032	1.206	1.810	2.413	3.016	3.619	4.223	4.825	5.429	6.032	6.635	7.239	7.842	8.415	9.048	9.651	10.26	10.85	11.46	12.06	12.67	13.27	13.87	14.48	15.08	450
460	.6166	1.233	1.849	2.466	3.083	3.700	4.316	4.933	5.550	6.166	6.783	7.399	8.016	8.633	9.249	9.866	10.483	11.10	11.72	12.33	12.95	13.57	14.18	14.80	15.42	460
470	.6300	1.260	1.890	2.520	3.150	3.780	4.400	5 040	5.670	6.300	6 930	7.560	8.190	8.820	9.450	10.08	10.71	11.34	11.97	12.60	13.23	13.86	14.49	15.12	15.75	470
480	.6431	1.287	1.930	2.574	3.217	3.861	4.504	5.148	5.791	6.434	7 078	7.721	8.365	9.008	9.651	10.29	10.94	11.58	12.23	12 87	13.51	14.16	14.80	15.44	16.09	480
490	.6568	1.314	1.971	2.627	3.284	3.941	4.598	5 255	5.912	6.568	7.226	7.882	8.539	9.196	9.853	10.51	11.17	11.82	12.48	13.14	13.79	14.45	15.11	15.76	16.42	490
500	.6702	1.340	2.011	2.681	3.351	4.021	4.692	5.362	6.032	6.702	7.373	8.043	8.713	9.383	10.05	10.72	11.39	12.06	12.73	13.40	14 08	14.75	15.42	16.09	16.76	500
600	.8043	1.609	2.413	3.217	4.021	4.825	5.630	6.434	7 238	8.043	8.847	9.651	10.46	11.26	12.06	12.87	13.67	14.48	15.28	16.09	16.89	17.69	18.50	19.30	20.11	600
700	.9383	1.877	2.815	3.753	4.691	5.630	6.568	7.506	8.445	9 383	10 32	11.26	12.20	13.14	14.08	15.01	15.95	16.89	17.83	18 77	19.71	20.64	21.58	22.52	23.46	700
800	1.072	2 145	3.217	4.290	5.361	6.434	7.506	8 529	9.651	10.72	11.79	12.87	13.94	15.01	16.09	17.15	18.23	19.30	20.38	21.45	22.52	23.59	24.66	25.74	26.81	800
900	1.206	2.413	3.619	4.825	6.032	7.238	8.445	9.651	10.86	12.06	13.27	14.48	15.68	16 89	18.10	19.30	20.51	21.72	22.92	24.13	25.34	26 54	27.75	28.95	30.16	900
1000	1.340	2.681	4.021	5.362	6.702	8.043	9.383	10.72	12.06	13.40	14.75	16.09	17.43	18.77	20.11	21.45	22.79	24.13	25 47	26.81	28.15	29.49	30 83	32.17	33.51	1000
1200	1.609	3.217	4.826	6.434	8.043	9.651	11.26	12.87	14.48	16.09	17 69	19.30	20.91	22.52	24.13	25.74	27.35	28.95	30.56	32.17	33.78	35.39	37.00	38.61	40.21	1200
1400	1.877	3.753	5.630	7.507	9.383	11.26	13.14	15.01	16.89	18.77	20.64	22.52	24 40	26.27	28.15	30 03	31.90	33.78	35.66	37.53	39.41	41.29	43 16	45.04	46.92	1400
1600	2.145	4.290	6.434	8.579	10 72	12.87	15.01	17.16	19 30	21.45	23.59	25.74	27.88	30.03	32.17	34.32	36 46	38.61	40.75	42.90	45.04	47.18	49.33	51.47	53 62	1600
1800	2.413	4.826	7.239	9.651	12.06	14 48	16.89	19.30	21.72	24.13	26.54	28.95	31.37	33.78	36.19	38.61	41.02	43.43	45.84	48.26	50.67	53.08	55.50	57.91	60.32	1800
2000	2.681	5.362	8.043	10.71	13.40	16.09	18.77	21 45	24 13	26.81*	29.49	32.17	34.85	37.53	40.21	42 90	45 58	48.26	50.94	53.62	56.30	58.98	61.66	64.34	67.02	2000
2500	3.351	6.702	10.05	13.40	16.76	20.11	23.46	26.81	30.16	33.51	36.86	40.21	43.57	46.92	50.27	53.62	56.97	60.32	63.67	67.02	70 38	73.73	77.78	80 45	83 78	2500
	1	2	3	4	5	6	7

TABLE OF ELECTRICAL HORSE POWERS.

Read volts at top and ampères at side, or *vice versa*.

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The formula which was used to obtain the figures in this table is

$$\frac{\text{Volts} \times \text{ampères}}{746} = \text{Elec. h. p.}$$

AMPERES OR VOLTS.

Volts or ampères.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Volts or ampères.
101	3.520	3.655	3.791	3.926	4.062	4.197	4.332	4.468	4.603	4.739	4.874	5.009	5.145	5.280	5.416	5.551	5.686	5.822	5.957	6.092	6.228	6.363	6.499	6.634	6.769	101
102	3.555	3.692	3.828	3.965	4.102	4.239	4.375	4.512	4.649	4.786	4.922	5.059	5.195	5.332	5.469	5.606	5.743	5.879	6.016	6.153	6.290	6.426	6.563	6.700	6.836	102
103	3.590	3.728	3.866	4.004	4.142	4.280	4.418	4.556	4.694	4.832	4.971	5.109	5.247	5.385	5.523	5.661	5.799	5.937	6.075	6.213	6.351	6.489	6.627	6.765	6.903	103
104	3.625	3.764	3.903	4.043	4.182	4.321	4.461	4.601	4.740	4.879	5.019	5.158	5.298	5.437	5.576	5.716	5.855	5.995	6.134	6.273	6.413	6.552	6.692	6.831	6.971	104
105	3.660	3.800	3.941	4.082	4.223	4.363	4.504	4.645	4.786	4.926	5.067	5.208	5.349	5.489	5.630	5.771	5.912	6.052	6.193	6.334	6.475	6.615	6.756	6.897	7.038	105
106	3.694	3.836	3.979	4.121	4.263	4.405	4.547	4.689	4.831	4.973	5.115	5.257	5.399	5.542	5.684	5.825	5.968	6.110	6.252	6.394	6.536	6.678	6.820	6.962	7.105	106
107	3.729	3.873	4.016	4.160	4.303	4.446	4.590	4.733	4.877	5.020	5.164	5.307	5.450	5.594	5.737	5.881	6.024	6.168	6.311	6.454	6.598	6.741	6.885	7.028	7.172	107
108	3.764	3.909	4.054	4.198	4.343	4.488	4.633	4.777	4.922	5.067	5.212	5.357	5.501	5.646	5.791	5.935	6.081	6.225	6.370	6.515	6.659	6.804	6.949	7.094	7.239	108
109	3.799	3.945	4.091	4.237	4.383	4.529	4.676	4.822	4.968	5.114	5.260	5.406	5.552	5.698	5.845	5.991	6.137	6.283	6.429	6.575	6.721	6.867	7.014	7.160	7.306	109
110	3.834	3.981	4.129	4.276	4.424	4.571	4.718	4.865	5.013	5.161	5.308	5.456	5.603	5.751	5.898	6.046	6.193	6.340	6.488	6.635	6.783	6.930	7.078	7.225	7.373	110
111	3.869	4.017	4.166	4.315	4.464	4.613	4.761	4.910	5.059	5.208	5.357	5.505	5.654	5.803	5.952	6.101	6.249	6.398	6.547	6.693	6.845	6.993	7.142	7.291	7.440	111
112	3.903	4.054	4.204	4.354	4.504	4.654	4.804	4.954	5.105	5.255	5.405	5.555	5.705	5.855	6.005	6.155	6.306	6.456	6.606	6.756	6.906	7.056	7.206	7.357	7.507	112
113	3.938	4.090	4.241	4.393	4.544	4.696	4.847	4.999	5.150	5.302	5.453	5.605	5.756	5.908	6.059	6.210	6.362	6.513	6.665	6.816	6.968	7.119	7.271	7.422	7.574	113
114	3.973	4.126	4.279	4.432	4.584	4.737	4.890	5.043	5.196	5.349	5.501	5.654	5.807	5.960	6.113	6.265	6.418	6.571	6.724	6.877	7.029	7.182	7.335	7.488	7.641	114
115	4.008	4.162	4.316	4.471	4.625	4.779	4.933	5.087	5.241	5.395	5.550	5.704	5.858	6.012	6.166	6.320	6.475	6.629	6.783	6.937	7.091	7.245	7.399	7.554	7.708	115
116	4.043	4.198	4.254	4.509	4.665	4.820	4.976	5.131	5.287	5.442	5.598	5.753	5.909	6.064	6.220	6.375	6.531	6.686	6.842	6.997	7.153	7.308	7.464	7.619	7.775	116
117	4.078	4.235	4.391	4.548	4.705	4.862	5.019	5.176	5.332	5.489	5.646	5.803	5.960	6.117	6.273	6.430	6.587	6.744	6.901	7.058	7.214	7.371	7.528	7.685	7.842	117
118	4.113	4.271	4.429	4.587	4.745	4.903	5.062	5.220	5.378	5.536	5.694	5.853	6.016	6.169	6.327	6.485	6.643	6.802	6.960	7.118	7.276	7.434	7.592	7.751	7.909	118
119	4.147	4.307	4.466	4.626	4.786	4.945	5.105	5.264	5.424	5.583	5.743	5.902	6.062	6.221	6.381	6.540	6.700	6.859	7.019	7.178	7.338	7.497	7.657	7.816	7.976	119
120	4.182	4.343	4.504	4.665	4.826	4.987	5.147	5.308	5.469	5.630	5.791	5.952	6.113	6.273	6.434	6.595	6.756	6.917	7.078	7.239	7.399	7.560	7.721	7.882	8.043	120
121	4.217	4.379	4.542	4.704	4.866	5.028	5.190	5.353	5.515	5.677	5.839	6.001	6.164	6.326	6.488	6.650	6.812	6.975	7.137	7.299	7.461	7.623	7.783	7.948	8.110	121
122	4.252	4.416	4.579	4.743	4.906	5.070	5.233	5.397	5.560	5.724	5.887	6.051	6.214	6.378	6.542	6.705	6.868	7.032	7.196	7.359	7.523	7.686	7.850	8.013	8.177	122
123	4.287	4.452	4.617	4.782	4.946	5.111	5.276	5.441	5.606	5.771	5.936	6.101	6.265	6.430	6.595	6.760	6.925	7.090	7.255	7.420	7.584	7.749	7.914	8.079	8.244	123
124	4.322	4.488	4.654	4.820	4.987	5.153	5.319	5.485	5.651	5.818	5.984	6.150	6.316	6.483	6.649	6.815	6.981	7.147	7.314	7.480	7.646	7.812	7.979	8.145	8.311	124
125	4.357	4.524	4.692	4.859	5.027	5.194	5.362	5.529	5.697	5.865	6.032	6.200	6.367	6.535	6.702	6.870	7.038	7.205	7.373	7.540	7.708	7.875	8.043	8.210	8.378	125
126	4.391	4.560	4.729	4.898	5.067	5.236	5.405	5.574	5.743	5.912	6.080	6.249	6.418	6.587	6.756	6.925	7.094	7.263	7.432	7.601	7.769	7.938	8.107	8.276	8.445	126
127	4.426	4.597	4.767	4.937	5.107	5.277	5.448	5.618	5.788	5.958	6.129	6.299	6.469	6.639	6.810	6.980	7.150	7.320	7.491	7.661	7.831	8.001	8.172	8.342	8.512	127
128	4.461	4.633	4.804	4.976	5.147	5.319	5.491	5.662	5.834	6.005	6.177	6.349	6.520	6.692	6.863	7.045	7.206	7.378	7.550	7.721	7.893	8.064	8.236	8.408	8.579	128
129	4.496	4.669	4.842	5.015	5.188	5.361	5.534	5.706	5.879	6.052	6.225	6.398	6.571	6.744	6.917	7.100	7.263	7.436	7.609	7.782	7.954	8.127	8.300	8.473	8.646	129
130	4.531	4.705	4.880	5.054	5.228	5.402	5.576	5.751	5 925	6.099	6.273	6.448	6.622	6.796	6.971	7.145	7.319	7.493	7.668	7.842	8.016	8.190	8.365	8.539	8.713	130
131	4.566	4.741	4.917	5.092	5.268	5.444	5.619	5.795	5.971	6.146	6.322	6.497	6.673	6.849	7.024	7.200	7.375	7.551	7.727	7 902	8.078	8.253	8.429	8.605	8.780	131
132	4.601	4.777	4.954	5.131	5.308	5.485	5.662	5.839	6.016	6.193	6.370	6.547	6.724	6.901	7.078	7.255	7.432	7.609	7.786	7.963	8.139	8.316	8.493	8.670	8.847	132
133	4.635	4.814	4.992	5.170	5.349	5.527	5.705	5.883	6.062	6.240	6.418	6.597	6.775	6.953	7.131	7.310	7.488	7.666	7.845	8.023	8.201	8.379	8.558	8.736	8.914	133
134	4.670	4.850	5.029	5.209	5.389	5.568	5.748	5.928	6.107	6.287	6.466	6.646	6.826	7.006	7.185	7.365	7.544	7.724	7.903	8.083	8.263	8.442	8.622	8.802	8.981	134
135	4.701	4.886	5.067	5.248	5.429	5.610	5.791	5.972	6.153	6.334	6.515	6.696	6.877	7.058	7.239	7 420	7 601	7 782	7.932	8.143	8.324	8.505	8.686	8.867	9 048	135
140	4.879	5.067	5.255	5.442	5.630	5.818	6.005	6.193	6.381	6.568	6.756	6.944	7.131	7.319	7.507	7.694	7.882	8.070	8.257	8.445	8.633	8.820	9.008	9.196	9.383	140
145	5.054	5.248	5.442	5.637	5.831	6.025	6.220	6.414	6.609	6.803	6.997	7.192	7.386	7.580	7.775	7.969	8.164	8.358	8.552	8.747	8.941	9.135	9.330	9.524	9.718	145
150	5.228	5.429	5.630	5.831	6.032	6.233	6.434	6.635	6.836	7.038	7.239	7.440	7.641	7.842	8.043	8.244	8.445	8.646	8.847	9.048	9.249	9.450	9.651	9.853	10.05	150
155	5.402	5.610	5.818	6.025	6.233	6.441	6.649	6.857	7.064	7.272	7.480	7.688	7.895	8.103	8.311	8.519	8.727	8.934	9.142	9.350	9.558	9.765	9.973	10.18	10.39	155
160	5.576	5.791	6.005	6.220	6.434	6.649	6.863	7.078	7.292	7.507	7.721	7.936	8.150	8.365	8.579	8.794	9.008	9.223	9.437	9.651	9.866	10.08	10.29	10.51	10.72	160
165	5.751	5.972	6.193	6.414	6.635	6.857	7.078	7.299	7.520	7.741	7 962	8.184	8.405	8.626	8.847	9.068	9.289	9.501	9.732	9.953	10.17	10.40	10.62	10.84	11.06	165
170	5.925	6.153	6.381	6.609	6.836	7.064	7.292	7.520	7.748	7.976	8.204	8.432	8.660	8.887	9.115	9.343	9.571	9.793	10.03	10.25	10.48	10.71	10 94	11.17	11.39	170
175	6.099	6.334	6.568	6.803	7.038	7.272	7.507	7.741	7.976	8.210	8.445	8.680	8.914	9.149	9.383	9.618	9.853	10.08	10.32	10.56	10.79	11.03	11.26	11.49	11 73	175
180	6.273	6.515	6.756	6.997	7.239	7.480	7.721	7.932	8.204	8 445	8.686	8.928	9.169	9.410	9.601	9.893	10.13	10.38	10.62	10.86	11 10	11.34	11.58	11.82	12.06	180
185	6.448	6 696	6.944	7.192	7.440	7 688	7.936	8.184	8.431	8.680	8.927	9.176	9.424	9.672	9.920	10.17	10 42	10.66	10.91	11.16	11.41	11.66	11.90	12.15	12.40	185
190	6.622	6.877	7.131	7.386	7.641	7.895	8.150	8.405	8.660	8.914	9.169	9.424	9.678	9.933	10.19	10.44	10.70	10.95	11.21	11.46	11.72	11.97	12.23	12.48	12.73	190
195	6.796	7.058	7.319	7.580	7 812	8.103	8.365	8.626	8.887	9.149	9.410	9.672	9.933	10.19	10.46	10.72	10.98	11.24	11.50	11.76	12.02	12.29	12.55	12.81	13.07	195
200	6.971	7.239	7.507	7.775	8.043	8.311	8.579	8.847	9.115	9.383	9.651	9.920	10.19	10.46	10.71	10.99	11.26	11.53	11.80	12.06	12.33	12 60	12.87	13.14	13.40	200
205	7.145	7.420	7.694	7.969	8.244	8.519	8.794	9.068	9.343	9.618	9.893	10.17	10.43	10.72	10.99	11.27	11.54	11.82	12.09	12.37	12.65	12.92	13.19	13.47	13.74	205
210	7.319	7.601	7.882	8.184	8.445	8.727	9.008	9.290	9.571	9.853	10.13	10.42	10.70	10.98	11.26	11.54	11.82	12 11	12.39	12.67	12.95	13.23	13.51	13.79	14.08	210
215	7 493	7.781	8.070	8.358	8.646	8.934	9.223	9.511	9.799	10.09	10.38	10.67	10.95	11.24	11.53	11.87	12.10	12.39	12.68	12.97	13.26	13.55	13.83	14.12	14.41	215
220	7.668	7.962	8 257	8.552	8.847	9.142	9.437	9.732	10.03	1 32	10.62	10.91	11.21	11.50	11.80	12.09	12.39	12.68	12.98	13.27	13.57	13.86	14.16	14.45	14.75	220
225	7.842	8.143	8.445	8.747	9.048	9.350	9.651	9.953	10.25	10.56	10.86	11.16	11.46	11.76	12.06	12.37	12.67	12.47	13.27	13.57	13.87	14.18	14.48	14.78	15.08	225
230	8.016	8.324	8.633	8.941	9.249	9.558	9.866	10.17	10.48	10.79	11.10	11.41	11.72	12.02	12.33	12.64	12.95	13.26	13.57	13.87	14.18	14.49	14.80	15.11	15.42	230
235	8.190	8.505	8.820	9.135	9.450	9.765	10.08	10.40	10.71	11.03	11.34	11.66	11.97	12.29	12.60	12.92	13 23	13.55	13.86	14.18	14.49	14.81	15.12	15.44	15.75	235
240	8 365	8.686	9.008	9.330	9.651	9.973	10.29	10.62	10.94	11.26	11.58	11.90	12.23	12.68	12.87	13.19	13.51	13.83	14.16	14.48	14.80	15.12	15.44	15.76	16.09	240
245	8.539	8.867	9.196	9.524	9.853	10.18	10.51	10.83	11.17	11.49	11.82	12.15	12.48	12.89	13.14	13.47	13.79	14.12	14.46	14.78	15.11	15.44	15.76	16.09	16.42	245
250	8.713	9.048	9.383	9.718	10.05	10.39	10.72	11.06	11.39	11.73	12.06	12.40	12.73	13.07	13.40	13.74	14.08	14.41	14.75	15.08	15.42	15.75	16.09	16.42	16.76	250
255	8.887	9.229	9.571	9.912	10.25	10.60	10.94	11.27	11.62	11.96	12.31	12.65	12.99	13.33	13.67	14.01	14.36	14.70	15.04	15.38	15.72	16.07	16.40	16.75	17.09	255
260	9.062	9.410	9.759	10.11	10.46	10.84	11.15	11.50	11.85	12.20	12.55	12.90	13.24	13.59	13.94	14.29	14.64	14.99	15.34	15.68	16.03	16.38	16.73	17.08	17.43	260
265	9.236	9.591	9.946	10 30	10.66	11.01	11.37	11.72	12.08	12.43	12 79	13.14	13.50	13.85	14.21	14.56	14.92	15.27	15.63	15.99	16.34	16.70	17.05	17.41	17.76	265
270	9.410	9.772	10.13	10.50	10.86	11.22	11.58	11.94	12.31	12.67	13.03	13.39	13.75	14.12	14.48	14.84	15.20	15.56	15.92	16 28	16.65	17.01	17.73	17.73	18.10	270
275	9.584	9.953	10.32	10.69	11.06	11.43	11.80	12.16	12.53	12.90	13.27	13.64	14.01	14.38	14.75	15.11	15.48	15.85	16.22	16.59	16.96	17.33	17.69	18.06	18.43	275
280	9.759	10.13	10.51	10.88	11.26	11.64	12.01	12.39	12.76	13.14	13.51	13.89	14.26	14.64	15.01	15.39	15.76	16.14	16.51	16.89	17.27	17.64	18.02	18.39	18.77	280
285	9 933	10.32	10.70	11.08	11.46	11.84	12.23	12.61	12.99	13.37	13.75	14.14	14.52	14.90	15.28	15.66	16.05	16.43	16.81	17.19	17.57	17.96	18.34	18.72	19.10	285
290	10.11	10.50	10.88	11.27	11.66	12.05	12.44	12.83	13.22	13.61	13.99	14.38	14.77	15.16	15.55	15.94	16.33	16.72	17.10	17.49	17.88	18.27	18.66	19.05	19.44	290
295	10.28	10.68	11.07	11.47	11.86	12.26	12.65	13.05	13.45	13.84	14.24	14.63	15.03	15.42	15.82	16.21	16.61	17.00	17.40	17.79	18.19	18.59	18.98	19.38	19.77	295
300	10.46	10.86	11.26	11.66	12.06	12.47	12.87	13.27	13.67	14.08	14.48	14.88	15.28	15.68	16.09	16.49	16.99	17.29	17.69	18.10	18.50	18.90	19.30	19.71	20.11	300
310	10.84	11.22	11.64	12.05	12.47	12.88	13.30	13.71	14.13	14.54	14.96	15.38	15.79	16.21	16.62	17.04	17.45	17.87	18.28	18.70	19.12	19.53	19.95	20.36	20.78	310
320	11.15	11.58	12.01	12 44	12 87	13.30	13.73	14.16	14.58	15 01	15.44	15.87	16.30	16.73	17.16	17.59	18.02	18.45	18.87	19.30	19.73	20.16	20.59	21.02	21.45	320
330	11.50	11.94	12.39	12.83	13.28	13.71	14.16	14.60	15.04	15.48	15.92	16.37	16 81	17.25	17.69	18.14	18.58	19.02	19.46	19.91	20.39	20.79	21.23	21.68	22.12	330
340	11.85	12.31	12.76	13.22	13.67	14.13	14.58	15.04	15.50	15.95	16.41	16.86	17.32	17.77	18.23	18.69	19.14	19.60	20.05	20.51	20.97	21.42	21.88	22.33	22.79	340
350	12.20	12.68	13.14	13.61	14.08	14.54	15.01	15.48	15.95	16.42	16.89	17.36	17.83	18.30	18.77	19.24	19.71	20.17	20.64	21.11	21.58	22.05	22.52	22.99	23.46	350
360	12.55	13.03	13.51	13.99	14.48	14.96	15.44	15.92	16.41	16.89	17.37	17.86	18 24	18.82	19.30	19.79	20.27	20.75	21.23	21.72	22.20	22.68	23.16	23.65	24.13	360
370	12.90	13.39	13.89	14.38	14 88	15.38	15.87	16.37	16.86	17.36	17.86	18.35	18.85	19 34	19.84	20.34	20.83	21.33	21.82	22 32	22.82	23.31	23.81	24.30	24.80	370
380	13 24	13.75	14.26	14 77	15.28	15.79	16.30	16.81	17 32	17.83	18.34	18.85	19 36	19.87	20.38	20 88	21.39	21.90	22.41	22.92	23.43	23.94	24.45	24.96	25.47	380
390	13.59	14.15	14.64	15.16	15.68	16.21	16.73	17.25	17.77	18.30	18.82	19.34	19.87	20.39	20.91	21.43	21.96	22.48	23.00	23.53	24.05	24.57	25.09	25.62	26.14	390
400	13.94	14.48	15.01	15.55	16.09	16.62	17.16	17.69	18.23	18.77	19.30	19.84	20.38	20.91	21.45	21.98	22.52	23.06	23.59	24.13	24.66	25.20	25.74	26.27	26.81	400
410	14.29	14.84	15.39	15.94	16.49	17.04	17.59	18.14	18.69	19.24	19.79	20.34	20.88	21.43	21.98	22 53	23.08	23.63	24 18	24.73	25.28	25.83	26.38	26.93	27.48	410
420	14.64	15.20	15.76	16.33	16.99	17.45	18.02	18.58	19.14	19.71	20.27	20.83	21.39	21.96	22.52	23.08	23.65	24.21	24.77	25.34	25.90	26.46	27.02	27.59	28.15	420
430	14.99	15.56	16.14	16.72	17.29	17.87	18 45	19.02	19.60	20.17	20.75	21.33	21.90	22.48	23.06	23.63	24.21	24 79	25.36	25.94	26.51	27 09	27.67	28.24	28.82	430
440	15.34	15.92	16.51	17.10	17.69	18.28	18.87	19.46	20.05	20.64	21.23	21.82	22.41	23.00	23 59	24.18	24.77	25.36	25.95	26.54	27.13	27.72	28.31	28.90	29.49	440
450	15.68	16.29	16 89	17.49	18.10	18.70	19.30	19.91	20.51	21.11	21.72	22.32	22.92	23.53	24.13	24.73	25.34	25.91	26.54	27.14	27.75	28.35	28.95	29.56	30.16	450
460	16.03	16 65	17.27	17.88	18.50	19.12	19.73	20.35	20.97	21.58	22.20	22.82	23.43	24.05	24.67	25.28	25.90	26.51	27.13	27.75	23 36	28.98	29.60	30.21	30.83	460
470	16.38	17.01	17.64	18.27	18.90	9.53	20.16	20.79	21 42	22.05	22.68	23.31	23.94	24.57	25.20	25.83	26.46	27.09	27.72	28.35	28.98	29.61	30.24	30.87	31.50	470
480	16 73	17.37	18.02	18 66	19.30	19 95	20.59	21.23	21.88	22.52	23.16	23.81	24.45	25.09	25.74	26.38	27.02	27.67	28.31	28.95	29.59	30.24	30.88	31.53	32.17	480
490	17.08	17.73	18.39	19.05	19.71	20.36	21.02	21.67	22.33	22.99	23.65	24.30	24.96	25.62	26.27	26.93	27 59	28.24	28.90	29 56	30.21	30.87	31.53	32.18	32.84	490
500	17.43	18.10	18.77	19.44	20.11	20.78	21.45	22.12	22.78	23.46	24.13	24.80	25.47	26.14	26.81	27.45	28.15	28.82	29.49	30.16	30.83	31.50	32.17	32.84	33.51	500
600	20 91	21.71	22.52	23.32	24.13	24.93	25.74	26.54	27.35	28 15	28.95	29.75	30.56	31.37	32.17	32.98	33.78	34.58	35.39	36.19	37.00	37.80	38 61	39.41	40.21	600
700	24.40	25.33	26.27	27.21	28.15	29.09	30.03	30.97	31.90	32.84	33.78	34.72	35.66	36.59	37.53	38.47	39.41	40 38	41.29	42.23	43.16	44.00	45.04	45.98	46.92	700
800	27.88	28 95	30.03	31.10	32.17	33.24	34.32	35.39	36.46	37.53	38.61	39.68	40.75	41.82	42.90	43.97	45.04	46.11	47.18	48.25	49.33	50.40	51.47	52.55	53.62	800
900	31.37	32.57	33.78	34.99	36.19	37.40	38.60	39.81	41.02	42.26	43.43	44.64	45.84	47.05	48.25	49.46	50.67	51.88	53.08	54.29	55.50	56.70	57.91	59.12	60.32	900
1000	34.85	36.19	37.53	38.87	40.21	41.55	42.90	44.24	45.58	46.92	48.26	49.60	50.94	52.28	53.62	54.95	56.30	57.64	58.98	60.32	61.66	63.00	64.34	65.68	67.02	1000
1200	41 82	43.43	45.04	46.65	48.26	49.87	51.47	53.08	54.69	56.30	57.90	59.52	61.13	62.73	64.34	65.95	67.56	69.17	70.78	72.39	73.99	75.60	77.21	78.82	80.43	1200
1400	48.79	50.67	52.55	54.42	56.30	58.18	60.05	61.93	63 80	65.68	67.56	69.44	71.31	73.19	75.07	76.94	78.82	80.70	82.57	84.45	86.33	88.20	90.08	91.96	93.83	1400
1600	55 76	57.91	60.05	62.20	64.34	66.49	68.63	70.78	72.92	75.07	77.21	79.36	81.50	83.65	85.79	87.94	90.08	92.33	94.37	93.51	98.66	100.8	102.9	105.1	107.2	1600
1800	62.73	65.15	67.56	69.97	72.39	74.80	77.21	79.62	82.04	84.45	86.85	89.28	90.69	94.10	96.51	98.93	101.3	103.8	106.2	108.6	111.0	113.4	115.8	118.2	120.6	1800
2000	69.70	72 39	75.07	77.75	80.43

mination of route, sinking of shafts, condemnation of property and provision of necessary machinery for work could be made in six months after a determined body of capitalists, armed with the proper franchise, which could be granted by the city, would be ready for operation, and the entire New York City line could be ready for active operation within 18 months thereafter. The cost of such a construction would be about $500,000 per mile of single tunnel.

How would you secure the effective ingress and egress of passengers to and from the stations?

Accessibiliy to all trains, no matter whether way or express, or for up or down or cross-town tracks, and for change from one train to another, is an important provision. This facility of access to trains can only be had where there is a common station, which station should be between the up and down tracks, and should be roomy, well lighted and easy to reach from the street. Sole dependence should not be placed on elevator service, although such should be provided whenever their use could be of advantage. At way stations a common platform between two tracks is easily provided, because the two tracks are on the same level, and there is nothing to provide for special changes. At the common way and express stations, however, a somewhat more elaborate station system should be adopted; the depth of the way tracks below the surface would be the same here as at regular way stations, but the express tracks would be about 13 feet lower, and preferably directly under the way tracks; thus the four trains would occupy the four corners of a parallelogram. Elevators when used should be in the centre of the station, open on both sides, and operated primarily by electricity. The entrance to stations should take no street room, and hence form no obstruction. The station and offices should occupy the first floor and deep basement of a building especially constructed for the purpose, all the upper portion of which could be utilized for ordinary business purposes, and two or more elevators could run the full height of the building from the station platform.

Crossings on grade would be rather risky underground, I presume?

There should be no grade crossings. While the importance of this rule has met little recognition in this country, and does not mark any widespread practice here, yet it is the standard practice of the main trunk lines in London. Its merits need little comment, because whatever other conditions may exist, high speed, safety and regularity of service can only be had in a fully satisfactory manner where there is a clear right of way.

A four-track system such as I have outlined, running up the east side, thence by loops through the annexed district and at the Harlem river, then down the west side, completing its circuit by way of the Battery, would necessarily have cross-town connections. These should be two tracks only, and should pass beneath the main system, with access from the common station, whether express or way, and as two-track systems they could be continued under the East and North rivers. One of the most useful of such cross-town connections would be a loop already described making connection between the New York City system and the various street railway and trunk line systems of Long Island City, Brooklyn, Hoboken and Jersey City, and whatever underground railway system might afterward be developed there. A two-track system for this loop would practically provide express service, because on a large portion of it, that under the rivers, there would be no necessity of stoppages, and the lines would be sufficiently long to allow of high speed.

From what you have already said, I presume you would virtually ignore the necessity of providing for connections with other lines?

I certainly would. The depth of the New York system of tunnels should be no more dependent upon that of the cross-town loop than upon the height of the elevated railroad or the Pennsylvania terminal tracks, the level of the horse car tracks, the platform of the ferry boats or the arch of the Brooklyn Bridge. It is impossible to accommodate all.

There should be no connection between an express and a way track, except at the dispatching and siding stations, where everything could be under the most rigid personal supervision, and where the necessary complication of tracks can be properly supervised. Switches, even between the way tracks and between the express tracks, should be used only in a case of emergency, and the main line of rails should be absolutely unbroken. The roadbed should be of the most rigid and even character, and the weight of rail commensurate with the duty.

Could you rely on such a system for improved train service?

Train intervals and passenger requirements should determine the length of trains, instead of length of trains determining train intervals. It is not express service to have to wait 10 or 15 minutes for an express train after leaving a way one. The most frequent interval that can be safely run is that which should be adopted, of course, with reasonable regard to the amount of passenger traffic, which, however, will be better accommodated at certain portions of the day by smaller units and more frequent trains. The number of cars in a unit determines the number of passengers that can be carried with a given safe interval between trains, because the time of discharging and taking on passengers will be almost constant with a given traffic per car, whether the trains be long or short. So long only as there is a safe interval between a train standing at the station and one approaching it, the train unit is not too small for passenger requirements, providing the following train is not delayed. When, however, the following train has to wait on approaching a station for another train to clear the way, the train unit is too small. The use of way and express tracks would relieve that congestion of traffic which characterizes the two-track systems of the elevated railroads, and which on any two-track road cannot be avoided in New York.

What should be the motive power of such a system as you have outlined?

Electricity will unquestionably be the motive power. The hum of the motor is the song of emancipation. As an independent way and express system of tracks should be an essential of a rapid transit system, so also should the use of electricity as a motive power be *sine qua non*, and accepting the statement that this agent is capable of satisfying in the highest degree the most exacting demands of service, the system should be planned with a special reference to its use. One great trouble with most of the rapid transit plans which have been proposed is that they have been designed from a steam engineer's point of view. Steam practice has determined not only the form of roadbed or tunnel, but also the laying of tracks, the construction of the cars, the ventilation and lighting of the trains and the roadway, the length of trains, the system of switching and dispatching—in short, there has been scant recognition of the fact that electricity has, within the past three years, jumped to the front with tremendous strides, and given practical and most conclusive proof of its pre-eminent fitness for at least all transit of this character. Many of these systems were planned before electricity was in its swaddling clothes, and even recently when electricity has been spoken of by the steam engineer, it has been with a somewhat indistinct idea that electrical engineers would fit their conceptions to steam demands. But this will not be done. The best informed of them know that the time has come when it will accept no secondary place; that there is nothing which steam can do in the matter of handling trains, certainly within the limits here considered which electricity cannot perform in a more satisfactory and a more perfect manner.

How far does the history of the development of electric traction corroborate this view?

The development of electric traction is unequaled in the industrial history of the world. In 1886 a list of twelve or thirteen comprised all the electrical roads in operation, and this included every electrical road in the world, whether operated by the split tube, the side rail, the traveling trolley carriage on an overhead wire, the centre rail, or by a conduit or storage battery. There was little similarity in these different plans, but they all served to show that electricity, in a more or less effective way, could propel a car. But street railway men were disbelievers, capitalists skeptical, car builders cynical, and most electricians only hopeful. Almost three years ago to-day, the 8th of February, 1888, there was opened for traffic, under the Sprague system, a road at Richmond, Va., which presented conditions of length, grade, curves, roadbed and number of cars to be operated, which, if successfully overcome, would mark a new era in the development of electrical railway traction. The conditions, while not perhaps now seeming remarkable, were then considered insurmountable, not only because of difficulties relating to street car service itself, but also the electrical and mechanical ones. The length was from eleven to twelve miles. There was a straight grade of 10 per cent.; there were grades in curves of 7 and 8 per cent.; there were twenty-nine curves, and some were as low as twenty-seven and thirty-foot radius. The road-bed was of an execrable character. Thirty cars had to be operated at one time from a common station, and some of them four miles away from the station. That road had its vicissitudes, but its victories as well. Forty cars were operated, and no less than twenty-two simultaneously at one end of the line. The electrical and mechanical features, hastily designed and crudely constructed, were a radical departure from previous work. They constituted what is known as the Sprague system, and, in the words of Franklin Leonard Pope, "Many of the characteristic features at that time designed and introduced have practically become standards in the modern system, and are found in nearly every one of the thousands of cars now in service."

The question of electrical propulsion was there settled, and that road stands as the pioneer of the marvelous development of the past three years, until there are now under operation in the United States alone no less than 310 electric railways, operating over 2,400 miles of track, with 4,000 cars, equipped with about 7,000 motors, representing no less than 175,000 horse-power in dynamos and motors. Not less than 400,000 miles are made a day, and nearly a billion passengers carried annually. Although only three years have passed, one-third of the entire mileage of street railways is electrical, and there is scarcely a road in the United States that is not considering the application of electricity.

How does electric traction compare as an investment?

Horse railroads which have been in use for over 50 years represent an investment of about $58,000,000; electric railways over $50,000,000, while the cable roads, which have had a commercial existence four times that of the electric system, have less investment than electrical railways, or about $49,000,000. So you see there is reason for my statement that there has been no equally remarkable growth in the industrial history of the world.

The equipment of roads by this system or detail modifications of it now constitutes a large proportion of the business of the largest four electric companies in the United States, and the system has not only gained such hold in this country, but is being introduced in Germany and Australia, is ascending the sacred hills of Fiesole, in Florence, and has invaded the dominion of the Mikado.

What is your opinion of the City & South London electric road running underground?

That road was first designed as a cable road, but the remarkable success of electric traction in the United States had much to do with the change to an electric system, which has been carried out with remarkable success under the supervision of Drs. John and Edward Hopkinson, and by the Messrs. Mather & Platt, of Manchester. New Yorkers are indebted to the energy and skill which has made the London road a success, because it stands in the same relation to city rapid transit as Richmond stands to the street railway development in the United States. It is the pioneer on a large and costly scale of an electric railway under new conditions which, with modifications, can be best applied to our own needs. It will do for capitalists who wish to embark in a rapid transit project what Richmond did for those interested in street railway service. It is, of course, a far more perfect equipment than was that of Richmond, for it had the advantage of two years' experience. That it can be improved upon is no criticism of it, but simply a statement that the ultimate, so far as the public is concerned, has not been reached in methods of motor construction and government.

In what respect would you propose to improve or modify the London system?

Well, first, with reference to the method of supplying the current. This will undoubtedly be by the overhead single conductor underneath contact system, with rail and tunnel return, despite the criticisms of what is properly known as the overhead wire system, which is the necessary street development, with many limitations, of the underneath plan. When such a system is used in the street it must necessarily be of light weight, have few supports at long intervals, sharp curves, heavy grades and sudden changes of grade. There must be a variation in height of wire from 21 to 12 feet from the ground, or 1 to 10 feet above the car to accommodate railway crossings and bridge roofs, and there must be a deviation of as much as four feet either side of a centre line. The conditions of construction cause more or less flexibility of the wire and of its supports, hence the trolley pole of the, as Dr. Holmes has so happily dubbed it, "broom stick train," must have a remarkable freedom of movement and the contact wheel must be grooved in order that the wire may govern the movements of the arm. Despite these great disadvantages of condition and service, when the line has been properly erected, the operation of the system is remarkably perfect under normal conditions, even up to a speed of 30 miles per hour, and with an ordinary street car.

With a tunnel road, however, the conditions are entirely changed, save only that we still wish to move a train guided only by its tracks, as nearly as may be, with perfect freedom between two planes. Here the overhead wire would be replaced by a rigid rail, supported by short intervals at a fixed distance from the roadbed, and following accurately the centre line of ail track and switch paths. The variation of distance from the motor car top will be practically nothing if a separate motor can be employed, and the settling of the car springs under a load, if the motor car carries passengers, would be the extreme limit of vertical movement. Grooved wheels and long poles would be discarded, and replaced by an upward pressing contact having a limited universal flexibility corresponding to the movements of the car upon its springs and any little irregularity of the tracks and the overhead conductor.

We would then have a system in which the electrical part, or rather the overhead conductor, because all parts would be electrical, would be just as rigid and permanent as the roadbed, and we should have perfection of insulation, freedom from personal liability, continuous contact with a single device, and speed limited only by the capacity of the motors. With such an overhead conductor, a speed of 120 miles per hour has already been successfully obtained on experimental work.

The so-called difficulties of the overhead system would then absolutely disappear. A centre rail system, with the conductor near the level of the tracks, must necessarily be broken at all switches, thus requiring double contacts on the motor car, and cannot offer the same advantages of insulation and freedom from personal contact. The overhead system would have been used upon the London road if there had been room enough. Of this I was assured by the consulting engineer of the road.

Then comes the consideration of the dynamos and motors?

The current could be supplied to this entire system for not only the motive power, but for lighting, and if necessary, for ventilation, by seven central stations situated on the water front at Kingsbridge, the Harlem River near 129th and near 160th streets, West Twenty-third

street, Jersey City, Atlantic Ferry and Greenpoint. With these stations the electrical potential would be comparatively low. The station would be operated by triple expansion condensing engines in three units, each driving a pair of multipolar slow speed dynamos directly coupled, the units being large enough so that two engines could handle the normal maximum demand upon the station. The economy of coal consumption under these conditions is too well known to need comment.

While for purposes of traction, getting quickly under way, and for marvelous braking power in case of emergency, a motor on every truck with control from a pilot car is possible, and would be a great service, I think it likely than an independent motor car will be found to be more advantageous, because of the care which the machines can have, the lack of necessity to subordinate the motor to abnormal conditions, and because, with the grades which an underground system will present, and with the constant coefficient of traction which the rails would have, a motor car could be relied upon to efficiently handle six times its own weight of passenger cars behind it. The multiplicity of parts should ordinarily be avoided, and the construction of the cars which the tunnel can best have might make the use of a motor under each and every car inconvenient.

It is unnecessary to go into the question of motor construction. Gearing will be done away with, slow-speed motors used, directly coupled, and it is safe to say that they will be quite as reliable as the best steam locomotive.

What system of braking would you advocate?

For use on an electric train, not only is every system of braking in common use, the vacuum, the air—whether the continuous pressure or the stored reservoir system—available, but more than this, and acting with a certainty, rapidity, and delicacy almost inconceivable, is the dynamo power of the motor system.

In a perfect system of transmission, every car running on a down grade, while not accelerating its speed, and every car coming to a stop ought to be of service in helping to propel other cars. As already pointed out, the work done on a train may be divided into three classes: First, the work of acceleratiag the speed, that is, from getting from zero up to its maximum speed, the process of imparting to the train a certain amount of stored-up energy which, when trains are stopped by the use of the brake in the ordinary manner, is nearly all wasted. Second, in lifting the train from one level to another, that is grade work; this is partially recovered on down grades, more so on express service than it can be on way service on account of the less frequent stops. Third, traction, the work expended in hauling a train on a level.

This would be true of the cable system also, would it not?

In a cable system running on a straight line, cars which are running on down grades do help to pull others on level or up grades, but the amount of power used to propel the cable itself is so largely in excess of that used for propelling the car that this is not of much importance, and on roads with curves it becomes even less so. Slowing down cars on cable roads is of no service in restoring energy to the system. In an electric car, however, when operated under proper conditions, all this is changed. There is intimate relationship between every foot of the system, and a train slowing down or a train running on a down grade can give back a large proportion of the energy to the system for use on other trains. The transmission of the energy by the current proceeds with calm indifference to grades and curves, or the condition of the thermometer or the barometer, and serenely annihilates time and space. Be it hot or cold, wet or dry, the interchange of energy is perfect.

This method of braking is of great commercial importance, since by it there is a saving of about 40 per cent. in the amount of power at the central stations, and it effects a similar saving in the size and cost of stations and conductors. Instead of the current being all supplied from the main generating stations, it would be supplied from nearly as many moving stations along the line as there would be trains slowing down or running on a down grade. In fact, the loss of the two conversions and one transmission would be fully counterbalanced, and the original horse-power at the central station would be no more than the aggregate net horse-power developed on the entire line.

Another method of using the motors for braking purposes is to break the connection with the line and reverse the machine through a local circuit on the train varying either the local circuit or the circuits of the machine. While in this position of braking, if the local circuit is opened and the line connection made, the machine would be instantly reversed.

How do these ideas stand the test of actual work?

Elaborate experiments have been made in handling a car without shoe-brakes by these methods of braking. When desired, the braking could be made so sudden as to cause the wheels to have a continuous skidding rotation, not such a skidding as is caused when an air brake is put on too sharply, but a rotating slip which is just enough to relieve the motor when the strain on it reaches the point determined by the coefficient of adhesion on the rails. This is the ideal method of braking, because fixed skidding and flat wheels are an impossibility, and the wheels will turn until the train comes to a dead stop, although, where the braking power is put on too suddenly and exceeds the grip of the wheels, they will relieve themselves by slipping just enough to keep the braking at the maximum limit. A train so governed can be made to creep down the maximum grade of a road at a snail's pace, and in an emergency such a car, running 21 miles an hour on a down grade, has been stopped and reversed within 90 feet.

When an electric motor is reversed, its action is cumulative, and thus much increases the effort to stop itself; and the higher the velocity at which it is traveling the greater this effort. In fact, it would be practically impossible with a properly constructed railroad motor to prevent its reversing when the switch is thrown over far enough.

Do any other points worthy of discussion occur to you?

I do not think further argument is necessary to demonstrate the advantages of the electrical method of propulsion. This being granted, we have at hand the means for the construction of a rapid transit road far in advance of any system at present operated and answering the peculiar demands of New York in the highest degree; a comprehensive system with way and express trains, starting and stopping promptly and smoothly, moving at a high rate of speed and running at short intervals, with none of the objectionable features of the present steam systems, and an enterprise having an incalculable influence on the future of this city, and on the health and happiness of our people.